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Letter from the Editor

Dear Reader,

In this fourth volume of the *Monarch Review*, we feature the work of more undergraduate students and more disciplines than ever—evidence that the journal continues to grow and become better known across the campus of Methodist University.

In fact, the journal has negotiated two perilous transitions to produce the current volume: In academic year 2016-2017, for the first time the journal lacked its founding senior student editor Miranda Friel. Cheri Molter stepped up and ably led the student staff who did the lion's work (last spring) of selecting and overseeing author revisions to the largest, most complex set of undergraduate research papers the journal has ever received. Also for the first time, we faced a complete turnover in student staff this past fall. The loss of experience and skill could have been disastrous; instead, the student staff now consists of nine smart, engaged undergrads who have taken to their responsibilities with enthusiasm and diligence. They are also the most diverse staff we've had and include freshmen and upperclassmen/women who represent a broad array of nationalities, ethnicities, and academic majors.

The papers published in this volume reflect the current preoccupations of the population at large: gender variability, gender oppression, conspicuous consumption, forms of religious life, public education of our children, environmental pressures, crime, health, and poverty. Essays range from a straightforward and thoughtful treatment of the father's role in breastfeeding to a complex analysis, via mathematical calculations and computer modelling, of ways to synthesize the therapeutic component of the ginger root. We present trenchant cultural criticism—Black Friday's consumption furor, the devaluing of public school teachers, Mexican village women pressing for equality—and highly technical analysis—forensic experiments, diagnosis of skin diseases of tropical sloths, and pharmaceutical chemistry. The nutritional needs of diabetics, indicators of poverty in the US, Franz Schubert's musical composition strategies, and a persuasive argument that Ernest Hemingway, that icon of masculinity, actually held a nuanced understanding of gender possibilities—who knew!—round out the papers in this volume.

The art work is similarly varied. The visual art includes marvelous charcoal drawings, several striking photograph, and provocative digitally created images. We present a flute performance and, in a real first, a traditional Indian dance performance. Contributing artist Tracey Raupp deserves a special shout-out: This amateur photographer has submitted dozens of photographs for each of the first four volumes of the *Monarch Review*, and every year we have published some of her images. But this year we've also used one of her photos, for the first time, on the cover of the journal.

L e t t e r f r o m t h e E d i t o r

Amateur artists, take note! You too can submit your work to the *Monarch Review*. At the very least, you'll receive some thoughtful and expert feedback. And you may get published and even make the cover.

Later this year, we will regretfully say good-bye to President Ben Hancock. If not for his support, this journal would not exist. The continuing presence of this platform for our undergraduates' work represents part of his legacy at Methodist University. Others—notably Provost Delmas Crisp, program directors Dr. Clay Britton (CRC) and Prof. Robin Greene (Writing Center), Miranda Friel, and Dr. Kelly Walter Carney—were also vital, early proponents of the *Monarch Review*. We hope they are pleased with the results of their vision. And we hope every member of the Methodist community is proud of this journal and the outstanding work of the undergraduate students of Methodist University.

May you enjoy volume four.

Best regards,

Baylor Hicks
Managing Editor

The Gender Continuum in Ernest Hemingway's War Novels

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Some contemporary feminist critics have labeled Ernest Hemingway's fiction as machismo, misogynist propaganda. However, a comprehensive character analysis of his war-related novels—*A Farewell to Arms*, *The Sun Also Rises*, and *For Whom the Bell Tolls*—suggests an entirely different, perhaps even progressive conclusion about Hemingway's writing. The protagonists of these novels are male war veterans who are struggling to cope with the disillusionment of World War I and the Spanish Civil War. Although the female characters are secondary, they too are forced to adapt to an evolving gender-role system: "As the war initiated and accelerated a period of sudden, often traumatic change, former structural relations between men and women became increasingly blurred...For many observers, the boundary between 'male' and 'female' was the most significant casualty of war" (Bonds 123-124). While some of the characters in Hemingway's war novels can be described as sexist stereotypes, many also blur the patriarchally defined gender role prescriptions; in creating such characters, Hemingway actually presents a continuum of gender.

Robert Jordan, the protagonist of *For Whom the Bell Tolls*, is a quintessentially if stereotypically macho man: he's an intelligent soldier who sacrifices his own life for a greater cause and whose only fear is "of not doing my duty as I should" (FWTBT 91). Ironically, his profound duty is to a republic to which he does not actually belong; Jordan is an American professor who teaches Spanish in Montana, so his overwhelming sense of duty to Republican Spain seems largely self-imposed, or even invented. Jordan "fervently" identifies with the cause of a country of which he is fond and in which he has spent a significant amount of time, but whether this provides enough motivation to risk one's life is questionable. Grand heroic behavior is characteristic of a "manly man"; he valiantly risks his life for a noble cause simply because he believes it is the ethical thing to do, even if the success or failure of that cause would only affect him minimally. Further indication of Robert's machismo is his ability to woo women. Jordan effortlessly romances Maria, and his success is remarkable if one remembers that Maria is a rape victim who is struggling with feelings of immeasurable shame when she first meets Jordan. It is through Jordan's love for her that Maria is again able to feel that she is worthy and capable of receiving love.

Even when circumstances prove dire and insurmountable, Robert remains in control and cool-headed; he cannot be shaken, and he never allows himself to panic. After he is crushed by his horse and suffers from a badly broken leg, he is able to convince his band of friends to leave him behind. His inner dialogue at this point reveals unimaginable bravery and unwavering, almost delusional confidence as he faces death: “There are many worse things than this. Everyone has to do this, one day or another. You are not afraid of it once you know you have to do it...Dying is only bad when it takes a long time and hurts so much that it humiliates you. That is where you have all the luck, see?...It’s wonderful they’ve got away” (*FWTBT* 466-468). In terms of a gender continuum, Jordan represents a thoroughly masculine figure.

Frederic Henry, the fascinating protagonist of *A Farewell to Arms*, purposefully shifts gender roles as he transitions from his role as a voluntary soldier bound by a loose sense of duty to his role as a lovesick deserter. At the beginning of the novel, Henry appears to be a fairly traditional masculine character. He is an American lieutenant who has bravely volunteered to serve alongside the Italian army in their ongoing war against the Central Powers, but unlike Robert Jordan, Henry volunteers for no compelling ideological reason. Rinaldi, a surgeon with whom Henry serves on the Italian front, remarks on the peculiarity of Frederic’s serving in the Italian army and asks Henry why he joined. Henry replies with ambivalence: “I don’t know...There isn’t always an explanation for everything” (*AFTA* 15). Although Henry lacks all sense of patriotism and does not identify with any political cause, he seems able to muster a vague sense of purpose in serving, which is one of protection: “I believe we should get the war over...It would not finish it if one side stopped fighting. It would only be worse if we stopped fighting...They [the enemy] come after you. They take your home. They take your sisters” (*AFTA* 43). After his extended hospital stay, Henry returns to his operations at the front, but he quickly loses what little sense of duty he previously held: “It evidently made no difference whether I was there to look after things or not...the whole thing seemed to run better while I was away” (*AFTA* 16-17). As Alex Vernon has argued, Henry’s military position offers him an opportunity that serves “as a liberation from domestic, economic, and social obligations, and a reassertion of manly autonomy” (38), but he appears neither to want nor care about such values. His fleeing the war is by no means a choice made out of cowardice: he escapes wrongful execution by frustrated, paranoid Italians. Moreover, by doing so he successfully escapes the patriarchal expectations set for him by fleeing to Switzerland with Catherine; Switzerland, as Marc Hewson asserts, “provides the lovers with an area outside the masculine laws of war and, by extension, outside the laws governing gender identity” (53).

Henry’s rejection of patriarchal expectations opens up an entirely new space for him to explore a different gender role. The social and environmental pressures to remain aggressive are removed once he is in Switzerland, and Henry relishes this newfound liberation by embracing passivity. As Vernon notes, during “Hemingway’s time [a passive position] was associated with the feminine” (37). After his desertion, Henry becomes utterly focused on Catherine, her pregnancy, and her happiness. This is a profound transformation as the earlier Henry had relations with prostitutes and saw Catherine as a fun distraction or as another sexual conquest. He also begins to exhibit a degree of open-mindedness about gender-bending. Catherine proposes cutting her hair short so that she

and her lover can have matching coiffures, and at first, Henry tells her, “I wouldn’t let you” (*AFTA* 299). Then, when Catherine presses him about it, he changes his mind



Ernest Hemingway in London at Dorchester Hotel in 1944, by unknown photographer. U.S. National Archives and Records Administration, National Archives Identifier 192672. <https://commons.wikimedia.org>.

desertion, and his embrace of a passive, unorthodox lifestyle that places him on a gender role continuum somewhere between a traditionally macho figure and an androgynous, domesticated one.

The most androgynous character in all of Hemingway’s war novels is undoubtedly Pilar from *For Whom the Bell Tolls*. Pilar’s physical description is almost entirely masculine:

Pilar is...a woman of about fifty almost as big as Pablo, almost as wide as she was tall, in black peasant skirt and waist, with heavy wool socks on heavy legs, black rope-soled shoes and a brown face like a model of a granite monument. She had big but nice looking hands and her thick curly black hair was twisted into a knot on her neck. (*FWTBT* 30)

Among her other masculine traits are her “deep voice” (*FWTBT* 30), and the gypsy calls her “something very barbarous...but brave” (*FWTBT* 26) and says that “she has a tongue that scalds and that bites like a bullwhip” (*FWTBT* 28). The critic Karen Engle makes an important observation of Pilar: “She is stereotypical of those women who are permitted to act as men and be treated as men. Pilar is neither sexually attractive nor in need of the

protection for which Maria's vulnerability cries out...That all on the mission see her as physically unattractive seems to lend her credibility" (948).

However, Pilar also occupies traditionally feminine spaces as well. She takes on several roles throughout the novel, and her most consistent role is similar to that of a homemaker: she cooks, she cleans, and she mothers Maria. She's even referred to as "Pablo's woman" several times before her actual name is introduced. Pilar also conveys her femininity through her sexuality. She nostalgically tells of her passionate younger days with an ex-lover who was a bullfighter, and she is not embarrassed to share when she has made love with Pablo. While some critics, Stacey Guill for example, consider her sexual openness as a sign that "she consistently ignores cultural propriety" (10), it is clear that her sensitivity is largely still intact despite the atrocities that she has both participated in and witnessed. Pilar discusses a particularly emotional incident that forced her to engage in intense introspection, and her subsequent feelings suggest a stereotypically feminine sensitivity: "I myself had felt much emotion at the shooting of the guardia civil by Pablo...I felt a feeling of shame and distaste...I wished that I might disassociate myself altogether from the lines, and I walked away...I felt an actual sickness in all of me inside and a sweating and a nausea as though I had swallowed bad seafood" (*FWTBT* 118-119). Pilar recognizes the ugliness of this man's death, and it profoundly affects her. While many critics deem Pilar a warrior figure, and she is, she is in touch with her femininity as well. Her gender blurring makes her an ideal center point on a gender continuum as she functions in both masculine and feminine roles.

Brett Ashley from *The Sun Also Rises* is an ideal depiction of a mostly traditional, mostly feminine woman who engages in behaviors typically reserved for men. Brett is repeatedly described as "lovely" throughout the novel, and yet her appearance is not entirely feminine. Her first description reads, "Brett was damned good-looking. She wore a slipover jersey and a tweed skirt, and her hair was brushed back like a boy's...She was built with curves like the hull of a racing yacht, and you missed none of it with that wool jersey" (*TSAR* 29-30). As Ira Elliott explains, "Brett...evokes androgyny and gender ambiguity in both physical appearance (her hair) and attire (her jersey)" (77). It is important to note that her femininity is not limited to her appearance. Toward the beginning of the novel, Brett drops by Jake's flat; he's lying face down on his bed feeling "rotten" and confesses, "Oh, Brett, I love you so much." Brett sits down next to him, kisses his forehead, strokes his head, and says, "Poor old darling" (*TSAR* 61-62). She responds to Jake's anguish with tenderness and sensitivity, perhaps even in a motherly way; it is in this context that her feminine, nurturing side shines. Later in the novel she selflessly leaves the handsome young bullfighter Romero: "I'm thirty-four, you know. I'm not going to be one of these bitches that ruins children" (*TSAR* 242). This is another instance in which Brett's sensitivity is evident. Todd Onderdonk suggests that "She herself worries that her actions are those of a 'bitch,' and she ultimately reins in her desires in order to spare Romero from destruction" (11). Several men are drawn to her irresistible charm and her beauty throughout the novel, and she does depend on men financially. After her break up with Romero, for example, she finds herself in need of help, and she relies on Jake to rescue her from the situation. In all of these ways she is a stereotypical, feminine figure.

In many other ways, however, she occupies a more masculine space. As critic Wendy Martin observes, "Brett aggressively expresses her sexual desires, while her lovers

wait to be chosen; she likes action—noisy public gatherings, large parties, the blood and gore of the bullfight” (Martin 75¹ qtd. in Willingham 44). Brett likes to party and drink; she does not confine herself to cafes and the theater. Moreover, Brett unapologetically exercises her sexual freedom throughout the novel, and her promiscuity is more characteristic of typical masculine behavior. Kathy G. Willingham notes, “Brett’s smoking, screwing, and swearing are not conventionally feminine traits” (44). She is also a risk-taker, which is another stereotypically masculine quality. By interacting with strangers, Brett places herself in potentially dangerous situations where she may be vulnerable, and she does this more than once with both the count and Romero. One could even argue that her escapade with Cohn is potentially dangerous considering they were not deeply familiar with one another. Beyond her immediate safety, “by exercising sexual freedom she risks disease, pregnancy, or ostracism” (Martin 77² qtd. in Willingham 48). Brett can neither be categorized as fully feminine nor ambiguously androgynous, so her character naturally falls somewhere between those distinctions.

If Robert Jordan is a figure who is fully saturated in masculinity, Maria from *For Whom the Bell Tolls* is his feminine complement. Her physical descriptions throughout the novel use provocative language that is indicative of traditional femininity. For example, Hemingway describes her breasts as “small, round, and tight” (*FWTBT* 356), and he projects a certain feminine innocence about her in the way that she “moved awkwardly as a colt moves, but with that same grace as of a young animal” (*FWTBT* 25). Despite her prior suffering of rape, Hemingway manages to retain a virginal quality in Maria given that she “cannot kiss...I do not know how...I have never kissed any man” (*FWTBT* 70-71). Her femininity is further evident in both her demeanor and behavior. As Stacey Guill comments, “nineteen-year-old Maria seems to exhibit the traditional behavior of the stereotypical Spanish woman: docility, subservience, and abnegation. She is Jordan’s ‘little rabbit’ and utters sentences such as, ‘and do you like me too? Do I please thee?’” (12). Not only is she obedient, but Maria is also sent away and excluded from conversations that surround politics and strategy. This exclusion implies that she is too fragile, too naïve, or simply incapable of worthy contribution in such domains, which are stereotypical justifications for the exclusion of feminine women. Furthermore, her actions at the camp are solely limited to cooking, cleaning, and having sex with Robert Jordan. Unfortunately, her earlier victimization seems to define her throughout the entire novel. It is important to note that while Maria is Hemingway’s most stereotypical depiction of a feminine damsel-in-distress, she also appears to make significant progress in self-development. She learns to shoot a gun, and she later experiences militant action first-hand. By the end of the novel, she is not entirely a victim.

Other characters are, of course, worthy of this same discussion: Jake Barnes, Pablo, Catherine Barkley, Rinaldi, and others. However, the characters discussed here are eloquent, distinct illustrations of a variety of genders on Hemingway’s gender continuum. As critic Linda Patterson Miller concludes, “There is no collective Hemingway man, there is no collective Hemingway woman” (10). Hemingway’s characters are multi-dimensional,

¹ Wendy Martin, “Brett Ashley as New Woman in *The Sun Also Rises*,” *New Essays on The Sun Also Rises*, Ed. Linda Wagner-Martin (Cambridge: Cambridge UP, 1987), 75.

² Wendy Martin, “Brett Ashley as New Woman in *The Sun Also Rises*,” *New Essays on The Sun Also Rises*, Ed. Linda Wagner-Martin (Cambridge: Cambridge UP, 1987), 65-82.

even when they are secondary, and their complexities suggest that he may not be quite the misogynist he is so often branded.

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A Gender-bound Domain in Teotitlán del Valle: The Evolving Roles of Zapotec Women

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Faculty Sponsor: Prof. Robin Greene

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Only fifteen miles east of Oaxaca City, Mexico, Teotitlán del Valle is a small village that is home to a community of Zapotec weavers whose ancestors have lived in the region for more than three thousand years. In her book *Oaxaca Celebration: Family, Food, and Fiestas in Teotitlán*, Mary Jane Gagnier de Mendoza writes, “With a population of more than eight thousand and practically every person over age fifteen participating in the weaving process, Teotitlán may very well be the largest hand-weaving community in the world” (18). As a result of the growing international interest in Zapotec weavings, it is “a place caught between a rapidly advancing future in export production and a long-entrenched past of ethnic uniqueness anchored in ongoing institutions” (Stephen 5). The international popularity of Zapotec woven products has created a tension between their new awareness of the world beyond their little village and their traditional, religious, simple Zapotec way of life. Although some Zapotec women have taken steps toward gender equality in the past thirty years, women continue to be oppressed in this Zapotec community by the normalization of institutionalized patriarchal ideology, which permeates the local government, the religious doctrine, and the culturally ascribed gender roles. Apart from a few pioneers, Zapotec women still largely live within an “enclosed garden” in which their labor is socially valued, but their voices, or any other expressions of autonomy, are not.

In her book *The Enclosed Garden*, Jean Friedman defines the term “enclosed garden” as the social boundaries placed on women by their patriarchal communities, revolving around church and kinship (xiii). Although her research was meant to illuminate the cultural restrictions on Southern women of the nineteenth century, Friedman’s metaphor of the enclosed garden also applies to Zapotec women in Teotitlán. According to Friedman, “[T]he social demands of integrated kinship networks, church discipline, and farm labor compressed southern women’s experience into the confines of a rural, kin-dominated, church-related community” (39-40). Throughout history, Zapotec women have lived within similar confines in the rural, pre-industrialized, predominantly Catholic Teotitlán del Valle, restricting their opportunity for independent growth and personal autonomy. For her book *Zapotec Women: Gender, Class, and Ethnicity in Globalized Oaxaca*, Lynn Stephen, an anthropologist who spent the 1980s and early 2000s studying

Zapotec culture and its gendered inequalities, interviewed multiple women—Isabel, Julia, Angela, and Alicia—whose stories reveal the difficulties of navigating their enclosed gardens in this small Mexican community. These women learn to cope with the inequalities, attempt to rectify them, or escape the societal boundaries inflicted by these inequalities, and their narratives inform this paper (Stephen 63-91).

Consistent with Friedman’s concept of how the “enclosed garden” takes shape, a church must ground the kinship-based community. In Teotitlán, the Catholic Church is influential in enforcing the boundaries that inhibit women’s behavior, both in private and in public. The village’s colonial-era church is positioned in the center of town, and passersby often stop at its gates to make the sign of the cross or kiss their rosaries before pursuing their errands. According to Gagnier de Mendoza, a woman from Canada who married a Zapotec man and moved to Teotitlán, “[T]hese people had a direct line with the gods. Faith was not something plugged into for an hour at Mass on Sundays. Religion was a part of daily life” (6-7). Catholic doctrine continues to shape Zapotec societal norms and church rituals, and fiestas “create a sense of belonging within the extended family, the church, and the community” (Gagnier de Mendoza 21). Compliance with the status quo assures one’s place within polite society.



The Roman Catholic Church in Teotitlán del Valle, March 2016. Photograph by author.

However, the Zapotec do not simply practice the same Catholicism often seen in the United States. Their age-old indigenous beliefs have long been integrated into their Christian practices. Gagnier de Mendoza writes, “The Catholic Church walks a fragile tightrope between enforcing official doctrine and tolerating indigenous idolatry. It is essential to understand that for much of the native population there is no difference between Christ, the Virgin, and the saints, or their statues. Kissing the carved wooden feet of a statue of Christ is to kiss God himself” (95-6). So when a family agrees to host the fiestas for the celebration of a saint’s day, family members are preparing grand community affairs with the belief that they are personally hosting the saint within their homes. Julia, a Zapotec woman born in 1929, “believes that sponsorship of rituals for the local saints is extremely important” (Stephen 65). Julia states, “In 1957 we were

mayordomos [hosts] for the Virgin of Guadalupe. Like many things then, my husband didn't tell me he had made a vow to be a mayordomo. Now [a widow] I decide these things. But I wasn't afraid then because...I had six years to get ready. ... There were three fiestas for this mayordomía and we were ready for them" (67). One's level of participation in these fiestas and religious rituals affects one's respectability in the community. Stephen writes, "While all members of the community are accorded respect by virtue of being born into and participating in the community, the amount of respect accorded to someone depends on certain criteria. Thus, while it implies equality because everyone is due it, it is not given in equal amounts to all people in the community" (47). Women were not allocated much respect; instead their place was, and to some degree still is, considered subordinate to the men.



The walled compound of Casa de Elenas, March 2016. Photograph by author.

In *The Enclosed Garden*, Friedman states, "In nineteenth-century culture, maternity, domesticity, [and] self-sacrifice...were expected of women," and these expectations that hindered the personal growth and mobility of the nineteenth-century women in the U.S. can be seen to hinder the Zapotec women of Teotitlán (40). According to Gagnier de Mendoza,

Firmly established moral codes inherent in rural Oaxacan communities clearly demarcate socially acceptable behavior especially for women. Whereas it is normal for young men, even those who are married, to hang out with primos [cousins] and amigos [friends] on street corners, a proper señorita would be severely criticized for doing the same. The public space outside the security of the walled family compound is seen as "uncertain"—fertile soil for gossip and speculation. (27)

The walled family compound was literally a young woman’s enclosed garden. Although not consistently practiced now, the traditional dress for Zapotec women always included an apron, which signified their status as a domestic in private and in public. In her interview, Julia states, “When I was first married I never left the house. Never. My husband would go alone to Oaxaca. He sold the blankets and kept the money. At first I didn’t even leave the house to buy food. I was too scared. I had never been out alone. ...A lot of women who were my age didn’t go on the street” (Stephen 66). Since she speaks of her experiences as a young woman, Julia refers to Teotitlán in the late 1940s. However, Angela discusses the village’s gender inequalities in the 1980s, stating, “You know men here can talk to any girl they want and women aren’t allowed to say anything. If women spoke to other men they’d get in trouble. Men are very jealous” (74). Julia and Angela both describe a patriarchal community in which men are empowered and entitled to control women’s behavior. Furthermore, Isabel, interviewed in 2004, attests to the fact



Street art in Teotitlán, March 2016. The inscription in red urges, “Join in ending violence against women.” Photograph by author.

that the social inequalities that mandated Julia’s and Angela’s behavior are still publicly reinforced in the 2000s. Isabel, born in 1982, fifty years after Julia, was raised by a single mother and has worked to improve the gender dynamics in the village, advocating for women’s equal rights. In her 2004 interview, Isabel states,

[W]hen we used to participate in the parades [to raise awareness for women’s rights], everyone said a lot of things to us in the streets...the men made fun of us. ...[T]hey would say...“How is it that your family lets you walk around in the street, going from one place to another? Don’t you have work to do at home? Why don’t you stay home and clean, make dinner, take care of the kids?” [T]hey would say to us

“Women shouldn’t be out on the street marching.”...I didn’t feel good when they said that to me. (Stephen 87-8)

The fact that Zapotec men were trying to shame women for being seen in public, suggesting that these women were only valued as passive domestic laborers, indicates that the men felt threatened by these women advocating for societal change. Many Zapotec men wanted to maintain the status quo as the dominant gender. As of twelve years ago, women like Isabel were deviating from the gender role expectations of their village, despite the male backlash they encountered. With perseverance and determination, Isabel, along with other women, worked to construct a new norm of culturally accepted female autonomy, thereby eliminating the boundaries of the socially constructed “enclosed gardens” of domesticity and subordination for women.

Up until the 1990s, most women were not permitted an education (Stephen 90). This fact hindered Zapotec women’s ability to take care of themselves and function in society without the constant support of the men in their lives. In her 1985 interview with Stephen, Julia said,

I don’t know how to read or write... You know last year I went to the school for adults that they had for one day. When I got home my husband said, “Why do you want to learn? You’re too old.” I do want to learn, and I need to know for my family. My daughter doesn’t know how to read; she didn’t go to school either. ... My husband doesn’t care about my granddaughter going to school... I think a lot of men are jealous when women learn to read and write and that’s why they don’t like it when their wives are educated. ... I need to learn [so I can get] to Oaxaca [City] and Tlacolula. I can’t read the street signs. (Stephen 68-9)

Julia knew that her lack of education not only hindered her ability to function as an individual but also restricted her movement, keeping her confined within the physical “enclosed garden” of her husband’s aunt’s walled courtyard. All the women whom Stephen interviewed discuss their lack of education—the highest level attained was sixth grade—and how that affected them in their lives (90). Born in 1953, Alicia describes how her father did not want her to go to school, despite her grandmother’s buying her a notebook and pencil so Alicia could attend classes (77). She states, “He came to the school to get me... I tried to go again, but neither my father [n]or my mother wanted me to go to school. They told me I didn’t need to go to school because I’m a woman. They said men go to school because they are men. I took care of the babies. Every year my mother had a baby. ... I was fourteen years old when I got married” (77). As an illiterate woman who understood the power to be gained with knowledge, Alicia’s grandmother was trying to help her granddaughter, but her lack of power to make her voice heard led to the continued practice of denying her family’s women their education and relegating them to a subordinate life with limited opportunities. According to Stephen, “migration has been a longstanding survival strategy” for Alicia (79). She moved to the United States in 1989, and “her very clear memories of being told that she did not need to go to school because she was a girl have stayed with [her] as she becomes aware of how important it is to read and write, particularly in a new environment” (79-80).

Nevertheless, not many Zapotec women could leave their village, let alone their country. Canadian transplant Gagnier de Mendoza states,

When I came to the village, women didn't drive, something I had done since my teens. But shortly afterward, my sister-in-law Marcelina became one of the village's first women with a license. I happily report that these days [2000s], long braids interwoven with thick satin ribbons are a common sight behind the steering wheel. Women here do not ride horses, but I regularly ride ours. (14)

Once Gagnier de Mendoza's sister-in-law saw that this Canadian woman who married her brother drove well and observed the freedom that the ability to drive afforded her, Marcelina, not surprisingly, wanted such freedom for herself. The introduction of new ideas to Teotitlán promotes an acceptance of the changes required to attain gender equality.

Until the 1980s, women were not permitted to get driver's licenses, a limitation that inhibited their exposure to the outside world. This meant they were reliant on men to drive them everywhere, and since many men felt women's "place" was within their walled courtyards, women rarely saw places beyond the village market and church. If a woman attempted even to escape temporarily from her "enclosed garden," she was seen as deviant and usually punished. Angela describes an example of this oppressive behavior:

Once when my father was in the hospital in Oaxaca, I went to visit him with my sister. We got a ride there in someone's truck. When I got home [my husband and my sister-in-law] slammed the door in my face. [My] father's dying, I'm very sad, and they shut the door in my face and call me all kinds of names for going to the city—whore, prostitute—just because I left and got a ride in someone's truck. (Stephen 74)

Such treatment is meant to shame Angela back into her "proper" place—her "enclosed garden"—and to enforce the status quo and the patriarchal power dynamic that subordinates women.

Although the anticipated domesticity and self-sacrifice of Zapotec women have been discussed in relation to their "enclosed gardens," their maternity is also expected. With the exception of Isabel, all of the women Stephen interviewed had at least two children. Several describe either their mothers or themselves as having a baby every year. The Catholic Church bans the use of birth control, and the resulting continuous pregnancies also hinder these women, burdening them with the task of constant childcare while their husbands are working away from the home. In keeping with the Zapotec male-dominated culture, baby girls are undervalued at birth. Angela explains,

When I was pregnant for the first time I went [to a wishing cave] and asked to have a son. ...I wanted to have a son because I thought that if I had a little girl, my mother-in-law would kick me out. When you have a baby people ask you, "*tengjum?Énĩ(ŋ)*" [Is it a little man?], with a smile on their face[s]. ...If it's a little girl they say, "*tezapε?ε(neŋ)*" [Hmmm,

it's a girl.] If it's a little boy they say, “*ʔkalbao tengjunweʔéñ(ŋ)*” [Lucky you, it's a little man]. (Stephen 72-3)

As is customary, Angela lived with her husband's family, so her fear of being kicked out for being pregnant with a baby girl is alarming. Women were raised believing they are worth less than their male counterparts from the time they are born, renewing the cycle of patriarchal ideology when they themselves become mothers. In order to raise young women who are not denied their self-esteem and education, the cycle must break and a new, more egalitarian attitude must become the social norm. Luckily, young women like Isabel offer proof that this change has been occurring over the past thirty years.



Cooking dinner on the comal, Teotitlán del Valle, March 2016. Photograph by author.



Flan at Las Granadas, Teotitlán del Valle, March 2016. Photograph by author.

The rituals that take place when a daughter leaves the home are interesting in that they reflect how girls are undervalued. According to Zapotec tradition, young women are “stolen”—the literal translation of the Spanish *robar*—by male suitors. A man takes a young woman to his parents' house to live as his wife-to-be (Gagnier de Mendoza 55). The language is significant because it implies that women are passive victims, thereby empowering men. In most cases, however, the woman voluntarily leaves with her boyfriend—actively participating—in what is basically an elopement. According to Gagnier de Mendoza, “Being ‘stolen’ has become over the last fifty years standard custom, and very likely the girl's own mother did the same thing. Nevertheless, the ensuing ritual, *Chisiak Lazá*, translated literally from Zapotec as ‘to content,’ can be best understood as a means of appeasing or contenting the girl's parents” (55). Mediators from the husband-to-be's family bring gold candles adorned with ribbon and wax flowers, and bowls of fruit and chocolate to the parents of the young woman, promising that their daughter will be taken care of in her new home. In essence, this dowry system allows for Zapotec daughters to be traded for candles, fruit, and chocolate; women

measure their “worth” by how many candles their parents received for them (Gagnier de Mendoza 66; Stephen 70). This tradition is still practiced today: Parents are contented by the glow of lit candles and the scent of the beeswax, and by the Wednesday and Sunday labor of their future sons-in-law, who sweep the porches of their father-in-laws-to-be as “replacements” for the work their daughters had performed (Gagnier de Mendoza 66).

Zapotec women’s domestic labor is expected and valued, but not compared to the value placed on men’s work. Since women started weaving, some of that division of labor has shifted a bit, but not to the extent that men are expected to help with domestic chores. Zapotec women’s voices are muted—seen as unequal to men in both private domains and public. However, the most recent generation of Zapotec women is trying to change this imbalance by becoming more active in the male-dominant politics of the village.¹ Isabel states, “Here women don’t really have a voice and a vote, only men, according to the custom. ...I don’t think that’s right. I think women should have the same rights as men” (Stephen 87). As a result of the feminist attitudes of young women like Isabel, Zapotec women’s “enclosed gardens” are opening up with new possibilities. According to Stephen, dissatisfied Zapotec women want more for their daughters and emphasize the importance of their education, not willing to allow their daughters to suffer as they have (90). With increased tourism and day trips to Oaxaca City, Zapotec women currently are exposed to more women of different cultures. Additionally, many Zapotec women have obtained driver’s licenses, and some now play in bands—an activity denied them until the 1990s. Furthermore, most women weave, allowing them some financial independence, and some are participating in local politics.

Like Friedman’s southern women of the nineteenth century in the United States, with all the same cultural limitations of a patriarchal society, many Zapotec women lived and died within their “enclosed gardens” of opportunity. Despite the slow social acceptance of education for girls and other egalitarian changes that have occurred in recent years—like women getting their driver’s licenses—many Zapotec women endure, still living within culturally ascribed boundaries that prevent them from experiencing autonomy and independence. Slowly, women’s rights are being recognized in Teotitlán del Valle, and the “enclosed gardens” of the local Zapotec women are expanding and allowing opportunities for personal growth and autonomy with fewer expectations for self-sacrifice.

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¹ Isabel and other Zapotec women have participated in local marches held to advocate for women’s suffrage. During Isabel’s interview with Stephen, she also discusses her regular attendance at the village’s political meetings, which are held to elect the town officials. Isabel reports that women have been allowed to attend these meetings for a while, but that female attendance is low. (Stephen 87-8)

The Cult of Consumer Capitalism and Black Friday, or the Evening Greenness in the West

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What Is Black Friday?

Rituals, and the myths that rituals express, undergo persistent change. The modern ritual associated with consumer capitalism is no different. Black Friday has taken on a variety of meanings depending on the era in which the term has been used. For instance, in 1869, Black Friday referred to the day the stock market crashed due to Jay Gould and Jim Fisk's attempt to corner the gold market and devalue American "greenback" currency.¹ More recently, in the 1980s, Black Friday has been appropriated to refer to "the day of the year when retailers hope to go from being in the 'red' (i.e. losing money) to being in the 'black' (i.e. making money)."² In what can be viewed as economic alchemy, retailers, marketers, and consumers coordinate in an attempt to transmute leaden losses into golden profits and create order from the previously associated chaos.

Thanksgiving, the day Americans gather with family and friends to give thanks by way of excessive feasting, has become a precursor to the day that the sales begin. However, these are no ordinary sales. In fact, these sales bring to life the metaphorical rat race that supposedly leads to a realization of the American Dream. In the wee hours of Black Friday, sleep-deprived shoppers jockey for position in line among throngs of other faithful shoppers as they await store openings. Once the doors open, a scene ensues that is reminiscent of *los toros bravos* thundering through the streets of Pamplona as the faithful crowd surges inside to fight, claw, and even kill to lay hands on the deeply discounted goods. If taken at face value, a possible conclusion is that Black Friday shoppers are only trying to obtain items they could not afford the rest of the year, albeit doing so in a frenzied manner. However, a closer look reveals that Black Friday shoppers are

¹ Donald P. Morgan and James Narron, "America's First Black Friday: The Gold Panic of 1869," *Financial History* no. 117 (Spring, 2016): 28-30. <http://ez-proxy.methodist.edu:2048/login?url=http://search.proquest.com/ez-proxy.methodist.edu:2048/docview/1803530333?accountid=12408>.

² Jane Boyd Thomas and Cara Peters, "An Exploratory Investigation of Black Friday Consumption Rituals," *International Journal of Retail & Distribution Management* 39, no. 7 (2011): 522. doi:10.1108/09590551111144905.

ritualistically reaffirming the use of objects (TVs, laptops, gaming consoles, automobiles, etc.) to express status and wealth.



Black Friday, 28 November 2013. Photography by Powhusku. <https://commons.wikimedia.org>

Civil Religion

What does it mean to be an American? In his article “Civil Religion in America,” Robert Bellah describes common beliefs that appear throughout the United States in a quasi-religious manner.³ To support his idea, Bellah highlights similarities between the constructs of recognized religions and those of his civil religion. Among these correlations, he notes that the civil religion is supported with cherished documents, such as the *Constitution*, and ideals like the veneration of freedom, the military, family, and individualism.⁴ Bellah explains that these tenets are overtly expressed on national holidays such as the Fourth of July (freedom), Memorial Day (the military), and Thanksgiving (family). Bellah does not address the American obsession with purchasing power as one of the key aspects of the civil American religion but does connect the preoccupation to a cultural display of utilitarianism in “Is There a Common American Culture?”⁵ Yet the excessive acquisition and display of material wealth seems to be too tightly interwoven into the American way of life to be considered a side effect or general expression.

³ Robert N. Bellah, "Civil Religion in America," *Daedalus* 134, no. 4 (2005): 40-55. <http://www.jstor.org/stable/20028013>.

⁴ Robert N. Bellah, "Civil Religion in America."

⁵ Robert N. Bellah, “Is There a Common American Culture?” *Journal of the American Academy of Religion* 66, no. 3 (1998): 614. <http://www.jstor.org/stable/1466136>.

Instead, consumer capitalism, complete with its own ritualistic day of observance known as Black Friday, deserves to be more properly positioned within the realm of civil religion.

The Good, the Bad, and the \$acred

Bellah states that “[o]ur cultural understanding of the world is shaped every time we enter a supermarket or a mall.”⁶ If Bellah’s claim is considered in conjunction with Mircea Eliade’s notion that the sacred gives shape to the world, it follows that American shopping centers are associated with something sacred.⁷ The apparent connection between shopping centers and the items housed in the shopping centers may lead to the conclusion that the items themselves are the sacred. However, in a country that focuses on the stock market, credit scores, and the holy word as echoed through the voice of profits, “the only thing more sacred than money is more money.”⁸

Considering Richard Walsh’s concept that “cross-culturally [the sacred is] the source of power and meaning,”⁹ one can begin to understand that money is power, that money greases the wheel and does, indeed, make the world go ’round. To have it is to be blessed; not to have it is to be damned. But regardless of status, one must acquire more money (or at least make everyone think, with all the nifty items purchased at a discount on Black Friday, that one has an abundance of money) in order to prove one’s value and place in society.

Thorstein Veblen’s *Theory of the Leisure Class* describes the measure of one’s worthiness as an effective tool for generating societal strata, i.e., creating a desirable in-group (the haves) and an undesirable other (the have-nots): “The concept of dignity, worth, or honour, as applied either to persons or conduct, is of first-rate consequence in the development of classes and of class distinctions.”¹⁰ Veblen also notes that such distinctions drive a love/hate relationship between the classes despite the conventional quest to obtain that fabled deluxe apartment on the East Side¹¹: “The possession of wealth confers honour; it is an invidious distinction. Nothing



Black Friday, by KERBSTONE. Creative Commons non-commercial license. <https://pixabay.com/en/black-friday-shopping-sale-discount-1042311>

⁶ Robert N. Bellah, “Is There a Common American Culture?,” 614.

⁷ Mircea Eliade, *The Sacred and the Profane: The Nature of Religion*, translated by Willard R. Trask (New York: Harcourt, Brace & World, 1959), 11.

⁸ Robert N. Bellah, “Is There a Common American Culture?,” 622.

⁹ Richard Walsh, “Part 2: An Anatomy of Religion,” *Walsh, Religion 404: Myth in Human Culture Course Documents* (Fayetteville, NC: Methodist University), accessed September 15, 2016, 1.

¹⁰ Thorstein Veblen, *Theory of the Leisure Class* (Auckland, NZ: The Floating Press, 2009), 9.

¹¹ Reference to the theme song from the television show *The Jeffersons*, which ran from 1975 to 1985 and portrayed the socio-economic ascent of an African-American family from a poor neighborhood in Queens, New York, to the upper-class island (both literally and figuratively) of Manhattan.

equally cogent can be said for the consumption of goods, nor for any other conceivable incentive to acquisition, and especially not for any incentive to accumulation of wealth.”¹² This love, hate, and envy cocktail drives people to great extremes to avoid slipping into a lower class by constantly updating, upgrading, and displaying goods that symbolize their wealth. Rather than associating good deeds with holiness, the members of this sect strive to achieve holiness through the Almighty Dollar. The driving force to emulate and idolize a higher state of being comes to life in George Ritzer’s description of Black Friday as an “annual pilgrimage” for those seeking absolution within the hallowed “cathedrals of consumption.”¹³

The Power to Purchase Compels Them: Sing a Song of Mythic Significance

The purveyors of any religion or belief system worth its salt are aware of music’s mind-altering capabilities. Evidence of such knowledge is seen in the repeated use of hymns, chants, mantras, and more to implant and reinforce messages in the minds of a community. Just as Orpheus plucked his lyre to bend the minds of the gods in his favor¹⁴, modern musicians are used to sway the minds of consumer capitalists in the United States. In order to provide context and purpose, the musical message is passed through a “cultural system of signification,” an intermediary that “inculcate[s] community members with the proper code and meaning” of that message.¹⁵ The packaged “proper” meaning places a heavy focus on elevating social status and transcending suffering through economic expression.

The commercial music and advertising industries in the United States (and worldwide as consumerism spreads) persuade the buying public by coupling popular music with their products. Take, for example, Janis Joplin, whose voice is intertwined with the 1960s’ U.S. counter culture. In her song *Mercedes Benz*, Joplin prays, “Oh Lord, won’t you buy me a Mercedes Benz. My friends all drive Porsches; I must make amends.”¹⁶ While Joplin may have co-written *Mercedes Benz* with a thick layer of sarcasm, the Mercedes Benz advertisers undermine the song’s original, sarcastic tone by using it to sell cars in a 2011 television advertisement.¹⁷ Once the song has been given its new, “proper” meaning, *Mercedes Benz* attributes a person’s material wealth and social standing

¹² Veblen, *Theory of the Leisure Class*, 14.

¹³ George Ritzer, *Enchanting a Disenchanted World: Revolutionizing the Means of Consumption* (Thousand Oaks, CA: Pine Forge Press, 2005), as quoted in Basil Cassell, *Consumer Holiday Structure: An Analysis of Christian Holiday Patterns and Consumer Ritual Practice in America* (MA Thesis, University of Missouri-Kansas City, 2010), 17.

¹⁴ Ovid, *Metamorphoses*, translated by Mary M. Innes (London, England: Penguin Group, 1955), 225-228.

¹⁵ Richard Walsh, “Procrustean Mythographers,” *Walsh, Religion 404: Myth in Human Culture Course Documents* (Fayetteville, NC: Methodist University), accessed on September 15, 2016, 14.

¹⁶ Janis Joplin, Michael McClure, & Bob Neuwirth, *Mercedes Benz*, Janis Joplin (Hollywood, CA: Columbia Records, 1971).

¹⁷ “Mercedes-Benz—Welcome—2011 Super Bowl Commercial Ad,” YouTube video, 1:01, Mercedes Benz automobile advertisement Feb 6, 2011, posted by crazycommercials4you, November 20, 2016, <https://www.youtube.com/watch?v=MSQCbWmJ8kU>.

to an act of divine intervention. Such an interpretation endorses the existence of a heaven-bound path that bypasses “the eye of the needle.”¹⁸

Not only do these consumer capitalist hymns encourage a compulsion to purchase (or pray for) and display status symbols, they also remind the listeners of their proper place in society based on the professions typically associated with their level in the pyramid of purchasing power. Thorstein Veblen describes a division of labor based on material wealth distribution as a “distinction between exploit and drudgery,” and he points out that “[s]uch employments as warfare, politics, public worship, and public merrymaking, are felt, in the popular apprehension, to differ intrinsically from the labour that has to do with elaborating the material means of life.”¹⁹ This same idea is echoed eighty-six years later in a catchy tune repeatedly broadcast on a television channel responsible for spreading the consumer society myth to the young minds of Generation X and beyond. In the critically acclaimed song *Money for Nothing*, Mark Knopfler, Dire Straits’ lead vocalist, belts out a tune lauding the media outlet MTV while simultaneously vocalizing the working stiff’s disdain and jealousy toward those who do not have to “work” for their posh lifestyle:

Now that ain't workin' that's the way you do it
Lemme tell ya, them guys ain't dumb
Maybe get a blister on your little finger
Maybe get a blister on your thumb.
We got to install microwave ovens, custom kitchen deliveries
We got to move these refrigerators; we got to move these color TV's.²⁰

These songs, and near countless others like them, reinforce the dominant mindset that wealth is the saving grace and deciding factor for one’s position in the have/have-not hierarchy. Once community members have been repeatedly bombarded with this story, the story becomes that community’s reality or “commonsense.”²¹

Let the Ritual Begin!

*Every time a bell rings, a consumer capitalist gets his things.*²²

Once the community members are on the same page, one need only provide a signal to elicit a Pavlovian response. The signal notes the beginning of a ritual and is important for transforming normal, everyday activities or items into sacred elements. For example, Walsh mentions the Catholic tradition of ringing a bell to signal the beginning

¹⁸ Matthew 19:24.

¹⁹ Veblen, *Theory of the Leisure Class*, 6.

²⁰ Mark Knopfler & Sting, *Money for Nothing*, Dire Straits (Montserrat: Warner Brothers Records, 1985).

²¹ Roland Barthes, *Mythologies*, translated by Anette Lavers, (New York: Hill & Wang, 1972). Barthes discusses multiple methods of myth dissemination and its part in creating segments of society through a shared interpretation of that myth.

²² This is a play on the phrase "every time a bell rings, an angel gets his wings" from *It's a Wonderful Life*, Frank Capra (director) (Culver City, CA: Liberty Films, 1946).

of communion and to transform wafers and wine into the body and blood of Christ.²³ The enactment of the Black Friday ritual is no exception. Days, sometimes even weeks, prior to the sacred sales, consumers are inundated with advertisements (some with recognizable songs as mentioned above) and reminders that the official holiday shopping season will soon begin. The fervor builds in anticipation of the approaching day—a holy version of the profane scavenger hunt for status symbols. In front of sacred shrines, the faithful crowds assemble and wait. The bell tolls, and the bulls burst through the corral.

Conclusion

In conclusion, the ritual known as Black Friday echoes the American focus on wealth to distinguish social status. To indicate superior class as well as the extent of one's worthiness, one must consistently adorn oneself with the latest, greatest products that symbolize wealth. Expressing wealth through the excessive consumption of goods seems to indicate a materialistic attempt to create an earthly version of heaven. However, to gain entry to this divine community, one needs an extensive collection of goods that have been purchased with the Almighty Dollar.

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The Debate on the Necessity of Church Buildings Through the Lens of the Wesleyan Quadrilateral

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In recent years, a debate has arisen in the Christian church regarding whether or not a congregation needs to possess its own physical building to fully respond to the call of the church.¹ In 2009, an article series in *Christianity Today* featured two writers representing both sides of this issue. Dan Kimball wrote, “If you had asked me eight years ago what I thought about the church buildings, I would have said, ‘Who needs a building?’...But I was wrong.”² Kimball then described the outreach his church had accomplished and asserted that “these missional opportunities would not be possible without a building.”³ In response, Ken Eastburn authored an article in *Christianity Today* proposing that Kimball’s new mindset is incorrect: “It is our consumer-mentality that causes us to think we need buildings. Buildings can be great tools, but the Church gets by...no, the church thrives...every day without them.”⁴ This debate has taken hold of Christian churches and affects the very roots of their ministry. Yet, when compared, the arguments against using a permanent building outweigh the arguments for a building. In the final analysis, buildings are superfluous to the church’s identity and function. The Christian church

¹ For example, arguments for having a building are advanced by Adam Delaplaine, “3 Reasons a Congregation Should Have Its Own Building,” *New Life Presbyterian Church Blog*, May 2014., accessed 19 March 2017, www.newlifepca.org/3-reasons-congregation-building/. For arguments against having a building, see “Churches Shouldn’t Spend So Much Money on Buildings,” *Debate.org*, March 2014, <http://www.debate.org/debates/Churches-Shouldnt-Spend-So-Much-Money-on-Buildings/1/>.

² Dan Kimball, “I Was Wrong About Church Buildings,” *Christianity Today*, December 2009, <http://www.christianitytoday.com/le/2009/december-online-only/i-was-wrong-about-church-buildings.html>. See also Delaplaine, “3 Reasons.”

³ Dan Kimball, “I Was Wrong.”

⁴ Ken Eastburn, “Wrong About Church Buildings 2: A Response to Dan Kimball,” *Christianity Today*, December 2009, accessed 7 May 2016, <http://www.christianitytoday.com/pastors/2009/december-online-only/wrong-about-church-buildings-2.html>. (Ellipsis marks in original.)

does not consist of the building, but rather is defined by the individuals who come together as one in the body of Christ.

Despite the modern context of this argument, one of the best ways to evaluate the debate is to learn from the roots of Christian church history. The history of the Methodist Church offers a rich and timeless resource in the evaluation of John Wesley's leadership. Wesley built his primary ministry strategy around a circuit-riding network structure. In other words, he and other preachers travelled by horseback to designated regions around England, holding services in public squares, fields, and even individual homes.⁵ Wesley found great success in operating without a building. Wesley not only provides a precedent for a non-building-centered outreach but also established a method of theological reflection as a conduit for decision-making, best known as the Wesleyan Quadrilateral—a method that can be adopted to address the church building debate.

In 1972, Albert Outler's construction of the Wesleyan Quadrilateral appeared in the *Discipline* of the United Methodist Church.⁶ Outler developed this construction based on his study of John Wesley's approach to "theological reflection"; the method rests on four main aspects—scripture, tradition, experience, and reason.⁷ Wesley began by using scripture because he insisted that the Word of God was and is the primary authority in Christian doctrine. He then employed tradition, which includes the history of the church, faith, or the entirety of Christianity as a lens for evaluation. Experience is based on the observations of past experience by the church and humanity in general. Finally, reason is the recognition that God's will for the question at hand might be sought by applying logic and reasoning. Just as Wesley utilized this method of theological reflection to discern God's will during his ministry, it can also be used to evaluate today's church building discussion.

Overall, the arguments for a dedicated building⁸ are weighty. Scripture recognizes the Solomonic temple's pivotal role in worship.⁹ Church tradition reveals the identification of church buildings with Christian practices and membership: "the church" became a means of describing the building, not the members.¹⁰ Moreover, experience and reason highlight the benefits of a central location and neutral space.

In contradistinction, elements of the Quadrilateral also argue against using a dedicated building. Scripture notes the importance of Christ's sacrifice as the final bridge closing the gap between God and man, undercutting the purpose of the temple.¹¹

⁵ Richard P. Heitzenrater, *Wesley and the People Called Methodists* (Nashville: Abingdon Press, 1995), 162.

⁶ Andrew C. Thompson, "Outler's Quadrilateral, Moral Psychology, and Theological Reflection in the Wesleyan Tradition," *Wesleyan Theological Journal* 46, no. 1 (2011): 49.

⁷ *The Book of Discipline of the United Methodist Church* (Nashville: United Methodist Publishing House, 2012), ¶105.

⁸ For this debate, a "building" will be considered a permanent structure that the congregation has either purchased, built, or leased. In these cases, congregations are in charge of the financial and physical upkeep of the building. On the other hand, "without a building" refers to a congregation that utilizes public spaces or individual houses for the church's needs.

⁹ E.g., 2 Kings 6:19.

¹⁰ James F. White, *Introduction to Christian Worship*, revised edition (Nashville: Abingdon Press, 1980), 97-108.

¹¹ E.g., Ephesians 2:19-22.

Tradition documents the history of successful itinerant ministries,¹² as well as the financial difficulties of a permanent building. Finally, experience and reason warn of the distraction and loss of ministerial focus that inherently come with building use.¹³

Scripture

Historically, the Israelites were required to have a building solely dedicated to God's presence. Exodus 40:34-35 describes the structure: "Then the cloud covered the tabernacle of meeting, and the glory of the Lord filled the tabernacle. And Moses was not able to enter the tabernacle of meeting, because the cloud rested above it, and the glory of the Lord filled the tabernacle." Therefore, early scripture recognizes the need for a space designed not only for the meeting of individuals but also for the recognition of God's holy presence.¹⁴ Further support for this argument is found in 2 Kings 6:19: "And he prepared the inner sanctuary inside the temple, to set the ark of the covenant of the Lord there." The ark of the covenant was a small gilded monument that was carried with the Israelites during their time in the desert. For them, it represented the presence of God and was placed in the inner sanctuary because of its holiness. With this in mind, many would argue that the core value of a church building is inherent in the scriptural need for a holy place, as described by these Old Testament passages.

Though some scriptural passages support having a building, other passages reject it. Wesley referred to Luke 14:23 as encouragement for ministry that does not require a building. This verse reads, "Then the master said to the servant, 'Go out into the highways and hedges, and compel them to come in, that my house may be filled.'" In this case, Wesley defined "house" as the comprehensive body of Christ or the Christian faith; he was not directly referring to the "house" as being the church building.¹⁵ Furthermore, in a sermon on Ephesians 4, Wesley expanded on his interpretation of the church itself, arguing that the church is not a building, but "the 'church' is... a congregation or body of people united together in the service of God."¹⁶ Wesley also used scripture to structure his small group ministry.

One of the most important facets of Wesley's circuit-riding ministry was the development of "classes" in the cities where he ministered. These classes were structured into what modern-day churches would consider "small groups." In his book *Fire of Love*, Gordon Wakefield describes how Wesley's intention for the groups was that they meet and conduct self-led discussions on their weekly experiences, scripture, and local developments.¹⁷ While planning the format for his small classes, Wesley utilized the book of James as a guideline for their day-to-day operation. In describing how the small groups should meet, he specifically cited a passage in James 5:16 as guidance for starting each

¹² Heitzenrater, *Wesley*, 103-104.

¹³ See discussion below.

¹⁴ James F. White, *Introduction*, 89.

¹⁵ John Wesley, "Of the Church," quoted in Albert C. Outler, ed., *John Wesley* (New York: Oxford University Press, 1964), 174.

¹⁶ Wesley, "Of the Church," quoted in Outler, ed., *John Wesley*, 308.

¹⁷ Gordon Wakefield, *Fire of Love: The Spirituality of John Wesley* (New Canaan: Keats Publishing, 1977), 41.

meeting¹⁸: “Confess your trespasses to one another, and pray for one another, that you may be healed. The effective, fervent prayer of a righteous man avails much.” Wesley’s use of scripture in the formation of these classes played a key role in his mobile ministry and in the development of its framework. For Wesley, the practices of the group were of central importance, not the space in which it met.

Finally, it is worth noting a passage in Matthew that does not support scriptural argument for a sanctified space. As mentioned above, many Old Testament passages refer to the need for this unique space; however, Matthew 27:51 reads, “Then, behold, the veil of the temple was torn in two from top to bottom; and the earth quaked and the rocks were split.” Solomon’s Temple was constructed with an inner sanctuary called the Holy of Holies, which was separated by a veil and said to be where the presence of God resided. However, only the high priest could enter this sanctuary once a year for the atonement sacrifice, and anyone else who entered was killed. The passage in Matthew expresses a metaphor about Christ’s death: The veil of the temple can be interpreted as an Old Testament symbol for the metaphysical barrier that sin creates between God and humanity, which prohibits individuals from coming into God’s presence. With Christ’s sacrifice, this barrier was torn, and people can now experience God through Jesus. The temple is no longer one’s only access to God. Thus, the passage serves as a rebuttal to the argument that a sacred space is necessary for the recognition of God’s presence.

Tradition

Historically, the roots of the Christian church lie in Judaism. The Jewish synagogue was a place of worship and reverence. Initially, the synagogue was organized and run by the local community and served as the central location of outreach and care for the surrounding area.¹⁹ These synagogues were the main locations for Jewish worship, although, perhaps because of Roman persecution, those of Christian faith did not establish similar buildings in the earliest years of Christianity. It was not until Constantine’s rule in Byzantium that Christians began to break ground on construction of their own permanent buildings.²⁰ In addition, Constantine ordered that many preexisting pagan temples, such as the Pantheon in Rome, be converted to Christian worship centers. These early churches marked the start of the church building movement and the end of Christian persecution in the Byzantine empire.²¹ This pattern of ministry continued to grow and to give rise to specialized church buildings up through the times of Medieval and Early Reformation practices until the time of Wesley.²²

Furthermore, support for a church building can also be found in Wesley’s leadership experience. Though his ministry was primarily on the move, he reluctantly decided to build a church building in Bristol, England. Traditionally, Wesley enjoyed the freedom of preaching in public locations where he could not be “turned out,” locations

¹⁸ Wakefield, *Fire*.

¹⁹ Eric M. Meyers, “Synagogue,” *Anchor Bible Dictionary*, David Noel Freedman, ed. (New Haven: Yale University Press, 1992) 6: 252.

²⁰ Kenneth Scott Latourette, *A History of Christianity: Beginnings to 1500*, revised edition (Peabody: Prince Press, 2007), 93.

²¹ Latourette, *History*, 92.

²² White, *Introduction*, 97-108.

such as parks, markets, or even cemeteries. However, the Methodist classes that met in Bristol “began to outgrow the homes in which they met.”²³ With this new development, the local societies—or collections of classes—decided to purchase land for a building. Fearing a potential loss of ministerial control, Wesley assumed financial responsibility for the project, “heeding [George] Whitfield’s warning that if he didn’t, [church] trustees could turn him out of the building if they didn’t like his preaching.”²⁴ Humorously, this meant that Wesley was now threatened with the possibility of truly being “turned out.” Although Wesley relinquished his freedom to preach in a variety of locations, the developments in Bristol indicate that, above a certain population, congregations are inclined to want a dedicated building in order to formally meet.

Nonetheless, resistance to the notion that a dedicated building is necessary persisted throughout Christian history, having begun even in Jesus’s time, when the initial ministry by the apostles and first followers of Christ took place in homes instead of central church buildings. These house churches were likely set up by the apostle Paul in his early ministry when he, “usually with one or more companions, carried the Christian message into much of Asia Minor and into Macedonia and Greece.”²⁵ After Paul set this standard, the early church members continued to meet in homes, catacombs, and other such spaces, holding “their services either secretly or without public announcement”²⁶ until Constantine’s building campaign commenced. Yet Paul’s pattern of meeting in existing, undedicated buildings continued even up to Wesley’s time. Both John Wesley and Paul had similar outreach formats that required them to travel around the surrounding country and establish house churches or small classes. And, as evidenced by their respective ministries, these forms of ministry without dedicated church buildings were highly successful in their own times,²⁷ so much so that the forms were carried on after Wesley’s time and are still applicable to present generations.

Today, many churches have encountered challenges with their buildings, and even John Wesley himself experienced the difficulty of managing a building in ministry. At one point, the debt of the building in Bristol became the primary concern of the small group meetings, overriding their regular meeting activities: “The debt on the New Room was being discussed at Bristol... Captain Foy, proposed each member of the society should give a penny a week toward clearing it.”²⁸ The financial pressure is one fundamental problem that challenges the argument for purchasing a building once the congregation exceeds its holding capacity. Alternatives to purchasing a building include utilizing public spaces or splitting the congregation into smaller groups. Wesley witnessed firsthand the financial difficulty of a dedicated building and recalled that “it was pointed out that a penny a week was beyond the means of many members.”²⁹ The focus of the ministry was taken away from the development of the body of Christ among the believers and put on the discharge of the debt incurred for the physical building. This

²³ Heitzenrater, *Wesley*, 103.

²⁴ Heitzenrater, *Wesley*, 104.

²⁵ Latourette, *History*, 73.

²⁶ Latourette, *History*, 81.

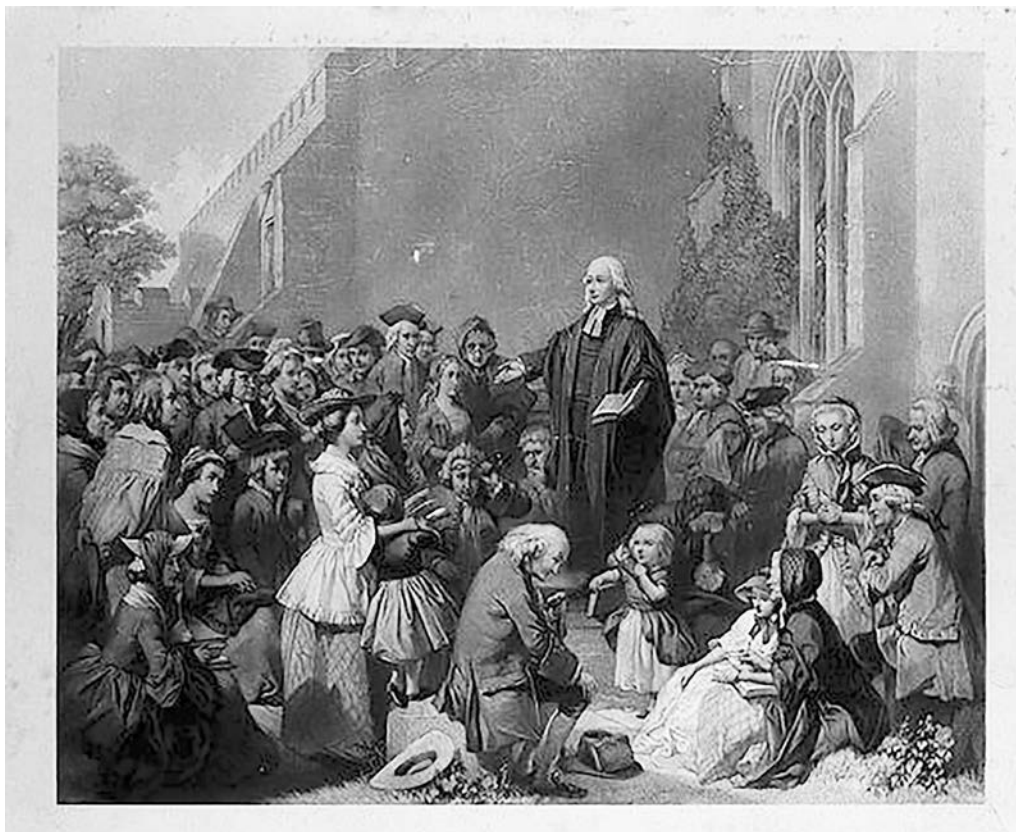
²⁷ Heitzenrater, *Wesley*, 306.

²⁸ David Lowes Watson, *The Early Methodist Class Meeting: Its Origins and Significance* (Nashville: Discipleship Resources, 1985), 93.

²⁹ Watson, *Class Meeting*, 93.

was one of the nightmares that Wesley wanted to avoid in his ministry, yet unfortunately his fears became all too real.

Although Wesley finally purchased a building, the dedicated building was a concept that contradicted his model of outreach. Wesley was a circuit rider by nature, but his dedication to this ministry model was not strong enough to oppose the desires of his church in Bristol. He acquiesced to help purchase the building in Bristol only after he felt threatened with a loss of control of his own ministry; he feared that, if he did not have some degree of ownership in the building, “trustees could turn him out of the building if they didn’t like his preaching.”³⁰ Additionally, though most ministers in his time were dedicated to a specific parish in the Church of England, Wesley thought quite the opposite: “Wesley felt that his calling as well as his ordination made it necessary for him to disregard parish boundaries and normal parish protocol in his attempts to fulfill God’s commission to him to preach the gospel”; as he proclaimed “the world is my parish.”³¹



John Wesley preaching outside a church, n.d. Engraving by unknown artist. Wellcome Library photo number V0006868.

This mentality does not support the purchase of a building as Wesley did not see God’s outreach as being limited by a physical building. Indeed, not only has Wesley’s ministry

³⁰ Heitzenrater, *Wesley*, 103.

³¹ Heitzenrater, *Wesley*, 102.

extended beyond the land in which he preached, but it has also reached across the confines of time and impacts those of Christian faith today.

Experience and Reason³²

One of the most important benefits of having a permanent building is the establishment of a permanent location. With this, members of the church have a specific, central place that they identify as a common ground, or as Pastor Amanda Garber³³ describes it, a “home base.”³⁴ Also, potential members who are interested in coming to the church have a distinct location. This also creates a focal point for community outreach. For example, in a disaster situation, the community can more efficiently reach out to a church if it has a permanent building. Finally, this permanent location typically allows for more versatility in outreach options. A church with a permanent location may be able to host outreach such as youth sports programs, lock-ins, worship nights, etc. It is unlikely that these events would be possible without a dedicated building.

Unlike a house church, a permanent building is typically larger and allows newcomers to attend a church anonymously before committing. Typically, a small house church creates an intimate setting that makes it difficult for potential members to take advantage of the anonymity that a large building provides.³⁵ Also, house churches remove the neutrality of a gathering place. Since services or meetings are conducted in the house of a certain member, they occur in a non-neutral space. For example, if one member has a personal conflict with the house host member, it would distract from or even damage the relationship that member has with the rest of the congregation. Similarly, the host members may become distracted with the worry or concern that they need to be proper hosts in their own home for the rest of the members. In contrast, the permanent building becomes a neutral, anonymous space where members do not feel pressured as they might in the house church setting. Finally, a church building typically creates a space that feels sacred, or designed for worship. Churches based in houses or other rented buildings will not have the aesthetics or design that allow them to be designated worship places.

Among the three religious leaders interviewed by the author, all emphatically noted one problem that comes with a church building: loss of focus. Wesley encountered the same problem with the church in Bristol. The congregation inevitably becomes distracted with financial or managerial problems because of the building. Marty Cauley³⁶ explains this problem in today’s churches: “The mission of the church then shifts from

³² According to the Wesleyan Quadrilateral, experience and reason require personal reflections on the “full range of human knowledge, experience, and service” (*The Book of Discipline*, ¶104). Thus, the author conducted three interviews to acquire input from ministers presently working firsthand in the ministry field.

³³ Amanda Garber is the pastor of RISE, a United Methodist faith community in Harrisonburg, Virginia, that was started in 2010 in the basement of a Mediterranean restaurant. Amanda Garber, phone conversation with the author, April 12, 2016.

³⁴ Amanda Garber, phone conversation with the author, April 12, 2016.

³⁵ Amanda Garber, phone conversation with the author, April 12, 2016.

³⁶ Marty Cauley is the Director of Content and Coaching for the North Carolina Conference of the United Methodist Church, and oversees church planting in eastern/central North Carolina. Marty Cauley, email message to author, April 9, 2016.

being externally focused, reaching & serving the local community, to internally focused, maintaining and caring for the facility.”³⁷ In addition to loss of focus, oftentimes congregations will find that maintaining a building is too expensive, which again draws attention away from outreach and toward the sustainment of the property. Over time, churches can lose sight of their mission of fortifying the body of Christ and begin to focus on the mission of constructing the building instead.

Though centrality and neutrality may be attractive for some churchgoers, one study conducted by Charles Arn in 2009 indicates that, over the past ten years, 75 to 90 percent of his respondents started going to church for a different reason: “The friendship factor”; Arn notes that “[t]hose friends and relatives are critical to the growth of churches. They far outweigh factors like the facilities, music, preaching, or children’s ministry. . . .”³⁸ A keystone element of a smaller congregation is the ability to initiate and maintain personal relationships with visitors and members. And while churches with larger buildings may be able to hold more members in attendance, more people come and remain at church because of the relationships that are built more easily in small church settings.

Additionally, this small church model is starting to grow around the world, not just in popularity but also diversity. Mark Ogren³⁹ describes a new ministry that is taking shape around the world and emphasizing the belief that “the church is not a building. . . church is the body of Christ.”⁴⁰ Fresh Expressions is an outreach that began in the Church of England in 2004 in Britain, and since then has spread to the United States, Australia, New Zealand, and other places around the world.⁴¹ This outreach is a house church movement that focuses on gathering people of similar interests, goals, and ideas. There are surfer churches, cowboy churches, artsy churches, nature churches. Anything that might bring people together in Christ can be used as a focal point for a church as long as it meets certain criteria. Fresh Expressions articulates on its website four guiding principles that must be a part of each church in order for it to be considered part of Fresh Expressions: The church must be missional by reaching out to people who are not being served by any church at the time; it must be contextual, or focused on the culture and language of the people it is trying to reach; it must be formational, that is, focused on bringing people to Jesus; and it must be ecclesial, which means forming tangible Christian communities that can be set apart as churches in their own right.⁴² All of these aspects are essential to the house church movement, and all harken back to the ministry that John Wesley started in the 1700s.

³⁷ Marty Cauley, email message to author, April 9, 2016, available from the author.

³⁸ Rachel Willoughby, “3 Questions for Charles Arn,” *Christianity Today* (March 2009), n.p., accessed 30 January 2017, <http://www.christianitytoday.com/pastors/2009/march-online-only/3-questions-for-charles-arn.html>.

³⁹ Mark Ogren is the Director of Congregational Excellence for the Virginia Conference of the United Methodist Church, and he is responsible for church planting and development in Virginia. Mark Ogren, email message to author, April 8, 2016.

⁴⁰ Mark Ogren, email message to author, April 8, 2016.

⁴¹ “About—What Is a Fresh Expression?,” *Fresh Expressions US*, 2017, <http://freshexpressionsus.org/about/#what>.

⁴² “About.”

Conclusion

John Wesley's leadership model has a bearing on this debate. An assessment with the Wesleyan Quadrilateral in mind leads to the conclusion that the movement away from a permanent building to a church model without buildings will be of paramount importance to the advancement of the body of Christ in the world. Since support for both sides of the argument can be found by applying the Wesleyan Quadrilateral, the usefulness of church buildings cannot be completely dismissed. For some situations, buildings are useful; however, buildings can also limit ministry in a multitude of ways. As scripture, church history, and experience show, the Spirit of God is found flowing in the hearts of the faithful and not locked within the walls of a building. By removing the building and focusing on edifying the people, ministry can grow in a more personal way. Finally, without a building, people no longer "go to" their church, but rather they can "be part of" their church. In Christian belief, they then become part of the body of Christ. Indeed, this was the message that John Wesley, the apostle Paul, and Christ Himself set out to spread in ministry, crossing the borders of nations and the expanse of time.

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Death, the Trout, and the Maiden: Schubert's Instrumental Interpretation of His Lieder

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Europe in the nineteenth century played host to one of the most important intellectual and artistic movements in cultural history: Romanticism. The movement was a response to the influence of the cold and mechanical Industrial Revolution, and its focus was dramatic, emotive expression. These notions of Romanticism first emerged in literature, and its expressive characteristics were absorbed by the contemporary musical style, in reaction to Classical music's emphasis on the structure of musical composition. Composers during the Romantic period created works layered with emotive context. In vocal music, the Romantic qualities were especially prevalent in the Germanic regions of Europe, where the German *Lied*, or in its plural form *Lieder*, became the quintessential vocal genre of the Romantic period. The composer best known for his mastery of *Lieder* was Franz Schubert; however, he also wrote in instrumental genres. Using the third movement of the *Piano Quintet in A Major* and the second movement of the *String Quartet in D Minor*, this analysis will examine Schubert's treatment of his songs in an instrumental context. Though Schubert wrote the instrumental ensemble works independent of his *Lieder*, the style in which he treated borrowed thematic content was similar. Through his use of musical form and carefully planned deviations from the original *Lieder*, Schubert was able to successfully transfer his interpretive *Lieder* style to purely instrumental mediums.

Before discussing the instrumental works of Schubert based on his *Lieder*, it is important to understand his style within the context of the period. Schubert wrote a vast body of *Lieder*, due in part to their popularity as a genre. The German *Lied* genre involved a single vocal line with piano accompaniment, and, though the accompaniment could be simple or elaborate based on the composer's wishes, the accompaniment was as critical and requiring of "artistic interpretation" as the vocal line.¹ Such importance was placed on interpretation because the lyrics to the *Lieder* were from pre-existing poetry, often contemporaneous. The prevalence and quality of Germanic poets like Goethe, Mayrhofer, and Schiller, all of whom provided texts that Schubert incorporated into his

¹ Michael Kennedy, "Lied, Lieder" in *The Concise Oxford Dictionary of Music*, 3rd ed. (London: Oxford University Press, 1980), 370.

Lieder, created an environment of rich source material that could be set to music. Thus one reason that German *Lieder* became integral to the Romantic movement was that they represented the synthesis of Romanticism as both a literary and musical movement.

Lieder were characteristically simple in terms of the vocal part, and the availability of piano for music-making in the home enabled *Lieder* to be consumed by the public en masse.² In terms of writing for voice, the simplicity of *Lieder* is a stylistic reaction to the exorbitant ornamentation and improvisation that was in vogue for the operatic singing style that had dominated the Classical period. The simplicity of Schubert's vocal parts did not mean Schubert limited himself to writing simplistically in the piano parts; some of them are demanding of the pianist while others are performable by amateur pianists. His variety of difficulty can be seen in comparing the piano accompaniments to *Die Forelle* and *Der Tod und Das Mädchen*.³

Example 1.1. Schubert, *Die Forelle*, mm. 1-2.⁴



Example 1.2. Schubert, *Der Tod und Das Mädchen*, mm. 9-10.⁵



The accompaniment to *Die Forelle* beginning in the first measure, though rhythmically repetitive, is highly involved in the context of the song: it mimics the rippling of the water the trout swims in. *Der Tod*, on the other hand, has accompaniment beginning in m. 9 that serves mainly to advance the song rhythmically while also offering harmonic support to the vocalist.

² “Schubert’s *Lieder*: Settings of Goethe’s Poems,” OpenLearn: Free Learning from the Open University, 2017. <http://www.open.edu/openlearn/history-the-arts/history/history-art/schuberts-lieder-settings-goethes-poems/content-section-0> (30 January 2016).

³ The *Lieder* titles translate to *The Trout* and *Death and the Maiden*, respectively.

⁴ Franz Schubert, *Die Forelle* in Franz Schubert’s *Werke, Serie XX: Sämtliche einstimmige Lieder und Gesänge* (Leipzig: Breitkopf & Härtel, 1895).

⁵ Franz Schubert, *Der Tod und Das Mädchen* (Vienna: Diabelli, 1822).

The importance of both the accompaniment and the vocal parts helped distinguish Schubert's *Lieder* in how thoroughly the music serves the overall meaning of the source text. The emphasis placed on the text, which served as the base for Schubert's lyric selection, reflected the nature of the Romantic movement, which was not isolated to music alone, but also branched into literature and philosophy.⁶ German literature, poetry in particular, truly began to flourish in the 19th Century, which coincided with the Romantic period.⁷ This meant that Schubert and his contemporaries had access to a vast array of poetic works from which songs could be created. The creative process was not limited to the choice of poem for text setting, but was expanded to include interpretation of the text via the text setting—the musical accompaniment. Schubert's poetic interpretations were done meticulously, and he paid attention to the minute details within a text, such as passing phrases or even a single word.⁸ These details were then incorporated into the lyrics, which were often direct quotations of the poems, and into the music Schubert wrote, either in a melody, musical accents, a harmony, or even the rhythmic figures of the accompaniment. Measures 26–32 of *Die Forelle* present one of the best examples of this thorough interpretation. The following musical example is from mm. 29 and 30 since it features the important segments that occur throughout the larger section.

Example 2. Schubert, *Die Forelle*, mm. 29-30.⁹



Though the vocal line is significant for advancing the story told through the text, the musical interpretation of the accompaniment is of greater importance in this section. Partly, this has to do with Schubert's propensity for finding the best rhythm or figure to create the desired mood or effect.¹⁰ In m. 29 of *Die Forelle*, the piano part becomes busy, with constant arpeggiation of chords. It replaces the lilting, lackadaisical flow of the accompaniment up through m. 25. The significance of this shift lies in its parallel to what

⁶ Lisa Feurzeig, *Schubert's Lieder and the Philosophy of German Romanticism* (Farnham: Ashgate Publishing Limited, 2014), 2.

⁷ Germany as a country did not exist in Schubert's time and would not until 1871; however, the Germanic cultural heritage was recognizable through much of Europe, and any reference in this paper to Germany refers to the Germanic regions.

⁸ Brian Newbould, *Schubert: The Music and the Man* (Berkeley: University of California Press, 1997), 147.

⁹ Schubert, *Die Forelle*.

¹⁰ "Franz Schubert: Music for Solo Voice & Piano," *FranzPeterSchubert.com*, n.d. http://www.franzpeterschubert.com/solo_voice__piano.html (22 January 2016).

is happening to the trout. The lyric “*Er macht das bächlein tückisch trübe*” translates to “[the fisher] makes the little brook muddy,” which would cause the trout to swim in panic.¹¹ This development explains why the piano accompaniment becomes more frantic: it represents both the muddying of the water and the panic of the trout. This passage is only one example of how Schubert took care to interpret a text completely, but it is this level of dedication to the source text that makes his *Lieder* so notable.

Even though Schubert is known for his numerous *Lieder*, he also wrote substantial instrumental works. In some of these pieces, Schubert revisited themes composed for his *Lieder*. This reuse of themes raises questions about how he treated the thematic material in a different medium, and in order to answer these questions, this analysis examines the *Piano Quintet in A* and the *String Quartet in D minor*. Both of these pieces have been given famous epithets because of their inclusion of thematic material from Schubert’s *Lieder*. The *Quartet in D minor* is referred to as the “Death and the Maiden Quartet” because of *Der Tod*’s appearance in the second movement, and the *Piano Quintet* is referred to as the “Trout Quintet” due to *Die Forelle*’s presence in the third movement.

Each instrumental work was written and published after its corresponding *Lied*. This sequence allowed time for the songs to work into public circulation, establishing widespread familiarity with these *Lieder*. In fact, *Die Forelle* was the *Lied* chosen for the Quintet because it was requested by the patron who commissioned the Quintet.¹² Though this explains the Quintet, the question of the Quartet’s inclusion of *Der Tod* remains unanswered. Schubert was by no means short on thematic material, as indicated by his large body of work, but his inclusion of themes that would have been relatively well known to a large number of people is curious. This familiarity could have been a tactic to sell more music. However, this hypothesis is unlikely for several reasons. The first has to do with how music was sold by utilizing the relationships between musicians, composers, and amateur musicians.¹³ Though music was designed to include a familiar theme, the inclusion would not be enough on its own, and the enthusiasm of other people was vital to popularize a new piece. The other reason that the inclusion of familiar themes would not have been a marketing ploy has to do with the names of the actual pieces. Both the Quartet and the Quintet follow a pattern of generic labeling of a piece with its genre and key signature, and the more individualized epithets by which the Quartet and the Quintet are known today arose after they were performed. Initially, people learned that *Lieder* themes were used in the instrumental works through actually playing them or hearing them played.

Because the thematic material was not for publicity purposes, the question of why the composer used pre-existing thematic material still remains. The answer lies in the form of each movement where the material occurs. Both the second movement of the “Death and the Maiden Quartet” and the third movement of the “Trout Quintet” are written in theme and variation form. This actually fits a pattern that occurs in Schubert’s *Lieder*. Whenever he revised a new setting, he elaborated on it instead of

¹¹ Translation by Katlin Harris.

¹² L. Michael Griffel, “*Der Tod und Die Forelle*: New Thoughts on Schubert’s Quintet,” *Current Musicology*, no. 79/80 (2005): 59.

¹³ William Weber, “Mass Culture and the Reshaping of European Musical Taste, 1770-1870,” *International Review of the Aesthetics and Sociology of Music* 25, no. 1/2 (1994): 179.

drastically changing it.¹⁴ The theme and variation form essentially allowed Schubert to continue elaborating on his theme in new and various ways. Schubert marked the Quintet into theme and variation sections. The “Thema” or theme section of mm. 1–21 begins the movement and is then followed by six variations, five of them labeled and the sixth being marked by a labeled tempo change that doubles as a style change. The Quartet, on the other hand, is not marked so obviously. There are no words delineating a theme section or variations. However, a mere glance reveals that the movement is rife with repeated sections that occur in a regular pattern. In mm. 1–24, the notable *Der Tod und das Mädchen* theme is introduced. Within this span there are two repeated sections; the first is from mm. 1–8 and the second is from mm. 9–24, and they create an 8:16 measure ratio.¹⁵ This ratio is the basis for each following unmarked variation, and the pattern of using repeat signs to mark sections is exactly the same until m. 137. At m. 137, there is no sign of repeat; however, the 8:16 ratio remains the same. The only departure from the 8:16 ratio occurs in mm. 177–180, and this is simply because this passage functions as the ending of the movement, thus giving it a sense of finality and completion. A harmonic analysis additionally shows that each section has a relatively similar harmonic pattern, even when the movement changes keys. The first section is centered around the minor tonic triad, followed by the second section, which is centered around the major submediant but cadences on the major tonic. There are also other chords within the sections, but the simplification $|| : i : || : VI I : ||$ best serves the overall pattern of minor transitioning to major that occurs in all of the variations. The form acts as Schubert’s musical canvas for his interpretation.

As previously stated, the *Lieder* that the thematic material came from were written prior to the creation of the instrumental works, and this means that Schubert already had interpreted the source texts. The question then becomes how he recreated the textual interpretation in a purely instrumental medium. To accomplish this, Schubert had to combine his pre-existing textual interpretation with new musical content. The result is a highly intellectual endeavor. The intellectual focus is a byproduct of the historical and cultural environment in which Schubert was living. In the 1800s, Europe was marked by the aftershocks of the French Revolution and by Napoleon’s political ideals. One of the main consequences was a shift away from aristocracy, which affected music directly because of its historic association with the aristocratic class.¹⁶ This meant that music as an art form would be linked to politics. This political linkage was widely and heavily felt, particularly in the late 19th Century, but the roots of the phenomenon took hold during Schubert’s time. The German government, in an attempt to stifle revolutionary thoughts from spreading to the populace, began to monitor its people.¹⁷ The hope of the governing elites was to prevent any insurrection based on revolutionary ideals, but they also understood that the written word was not the only way to disseminate views that they saw as detrimental to the existing political system. The

¹⁴ Reinhard Van Hoorickx, “Schubert’s Reminiscences of His Own Works,” *The Musical Quarterly* 60, no. 3 (July 1974): 378-9.

¹⁵ The description excludes the repetition of the section.

¹⁶ Celia Applegate, “How German Is It? Nationalism and the Idea of Serious Music in the Early Nineteenth Century,” *19th-Century Music* 21, no. 3 (1998): 286.

¹⁷ Andrew Hemingway and William Vaughan, *Art in Bourgeois Society, 1790 – 1850* (Cambridge: Cambridge University Press, 1998), 203.

societal monitoring was also extended to visual art and to vocal music, which, because of its ability to articulate actual words, was prone to censorship. Instrumental music of the Romantic period focused on emotions and could move people through the power of the musicians' abilities to create emotion with their playing. Emotions such as anger and



Portrait of Franz Schubert, 1797-1828, oil on canvas by Carl Jager. Public domain (PD-1923). https://commons.wikimedia.org/wiki/File:Portrait_of_Franz_Schubert_1797-1828,_oil_on_canvas_by_Carl_Jager

despair over existing political circumstances were at the root of many revolutionary thoughts, thus making them dangerous. The music's emotional context could then be indirectly influenced through piece titles and instrumental arrangements of vocal songs that could not otherwise be performed under censorship. Governments were less wary of

this subtle ability to express independent thought, which made instrumental music an ideal platform for subversive expression.

Schubert had firsthand experience with political oppression, and he actively fought against it in the defense of a friend who had spoken out against political repression. In 1820, the chambers of his friend Johann Senn were searched and his writings confiscated under official orders of the chief of police; Senn angrily began to argue with the police who were invading his liberties, and Schubert “chimed in against the authorized official... inveighing against him with insulting and opprobrious language,” for which he was then arrested.¹⁸ This incident shows that Schubert was not afraid of going against the political powers of the time in order to defend his friends and his core belief in civil liberties. Musically, this translates to his shift to composing instrumental works. Instrumental music featured no words to be censored, yet could still evoke desired moods and subtly undermine political powers of the time. Schubert made a drastic shift in 1824, the year the *Quartet in D Minor* was written, to compose fewer *Lieder* and more instrumental music.¹⁹ This later instrumental music is more complex, as seen in the differences in the theme and variations. The *Die Forelle* variations are significantly more straightforward in regard to the notable theme than are the Quartet’s variations. Recognizing the variations in the Quartet requires greater intellectual effort, but that subtlety does not impede Schubert’s ability to apply his textual interpretation from the *Lieder*; if anything, it actually elevates the interpretation.

An understanding of Schubert’s instrumental interpretation requires discussion of the differences in the *Lieder* as compared to the instrumental movements. Firstly, neither of the instrumental works is set in the original key of the *Lieder*.²⁰ Though this may seem like a small difference, it is important to evaluate the change because it is possible that the difference in key signatures exists for the sake of artistic interpretation. For the Quintet, the choice of key has to do with the overall form of the entire work. The Quintet is in A major, but *Die Forelle* is originally written in Db major. Db is not one of the notes found in the key of A major, and therefore would not be a key signature that appears within an A major work in accordance with traditional form. The reason for the key change is the change in instrumentation. Db major is a key that is more accessible to vocalists; however, for string players, Db major is more of a hindrance than A major. Therefore, this deliberate changing of keys is to facilitate performance rather than musical interpretation. The original key of *Der Tod* is D minor, and the Quartet is in D minor, yet the second movement, which contains the thematic content in question, is in G minor. Though Schubert could have used the original key, the use of a different key is feasible in the context of the larger work because the keys are separated by a fifth. This means that they are closely related in terms of their key signatures, and the *Lied* will not sound drastically different from the String Quartet. The change of keys is therefore not for interpretation, but in order to ease execution of the music and adhere to tenets of music theory regarding closely related keys.

¹⁸ Report from High Commissioner of Police von Ferstl, March 1820, in *Schubert: A Documentary Biography* (London: J.M. Dent & Sons LTD., 1946), 128.

¹⁹ Blake Howe, “The Allure of Dissolution: Bodies, Forces, and Cyclicity in Schubert’s Final Mayrhofer Settings,” *Journal of the American Musicological Society* 62, no. 2 Summer (2009): 276.

²⁰ Each key is composed of a different set of notes. Thus when a key is changed, the sound can be drastically different or slightly similar if the key signatures share similar notes.

The biggest difference between the *Lieder* and the instrumental works is how Schubert approaches the statement of the themes. The Quintet and the Quartet approach the themes and the manner in which they are varied in almost opposite ways. The theme used by the Quintet covers mm. 1–20 from the original *Lied*; however, the Quintet does not repeat where the *Lied* repeats. *Die Forelle* repeats from mm. 1–24 in order to create strophic verses before a change in character and melody. The Quintet, on the other hand, repeats mm. 1–8, which comprise roughly half of the first verse in the song, before finishing the theme in mm. 10–21. Additionally, the theme is not presented exactly as it is in the *Lied*. In the first few measures of the melody alone, the instrumental version has

Example 3.1. Schubert, *Die Forelle*, mm. 1-4.²¹



Example 3.2. Schubert, *Piano Quintet in A Major*, Op. 114, Mvmt. III mm. 1-4.²²



several dotted rhythms, which give the theme a lighter, more playful sound. More importantly, this rhythmic change prevents the string sound from being too sustained, which is uncharacteristic of the human voice. The different rhythm and articulation actually enable the strings to sound more buoyant and to mimic the crisp sounds of the German language. In addition to introducing more vivacious rhythms, the Quintet dispenses with the famous piano accompaniment of the original *Lied*. (See Example 1.1) The original accompaniment is not referenced until m. 133 at the beginning of the final variation. The articulation changes, but in almost every variation, the theme is easily visible to the players and audible to the listeners. In general, Schubert uses the formula of one part having the melody, one part having an ornamental line, and the other parts having filler notes and rhythms. Of most importance are the ornamental and melodic lines because they offer continuous movement underneath the melody. The Quartet, on the other hand, approaches the theme in an opposite manner. The theme utilized is from mm. 1–8 of *Der Tod*. Unlike the Quintet, the Quartet restates the original *Lied* exactly, though the parts appear voiced in a chorale-like manner instead of the close chords of the piano accompaniment. The theme is clearly and distinctly stated, but only two times: once at the beginning and then at m. 169, which is where the

²¹ Schubert, *Die Forelle*.

²² Franz Schubert, *Piano Quintet in A Major*, Op. 114 (Leipzig: Breitkopf & Härtel, 1886).

final variation begins to near its completion. Outside of these two instances, the other variations differ considerably from the original thematic content.

Given the deviations from the original *Lieder*, the question remains: how could Schubert have maintained a textual interpretation from the *Lieder*? The forms chosen prevented Schubert from utilizing the entirety of the *Lieder*, and the lack of text prevented any verbal communication. The verbal communication dilemma is solved in a rather simple manner. Music making in the 19th Century still placed a large emphasis on music in the home.²³ The fact that the instrumental works were published after the *Lieder* had been released for public consumption meant that the themes in and of themselves were recognizable to those who had heard the *Lieder*. Another possibility is that at least one person either playing the music or listening to its performance had earlier heard the corresponding *Lied*, thus enabling this person to tell others. The answer to these problems created by the form are actually solved by the form. Each individual variation can almost be viewed as a verse, and the “verses” that show drastic style differences correspond to mood change or the creation of conflict within the original *Lieder*.

The Quintet is the quintessential example of Schubert’s use of variation to create the textual interpretation. *Die Forelle* tells the tale of a trout that eludes capture by a fisherman until the fisherman disturbs the water, thus enabling him to capture the fish. In the instrumental work, the melody is always present and it is passed to a different member of the ensemble. It is written in a lively manner through the use of dotted rhythms and is kept moving forward by ornamented lines. This corresponds to the trout swimming peacefully in the water. The muddying of the water occurs in m. 89 at the start of Variation IV. Unlike the previous variations, this one does not utilize many dotted rhythms, instead opting for aggressive triplets and strictly rhythmic eighth notes. Its importance as a section is also marked by the only fortissimo in the entire movement, as well as the first key change from D major into D minor. By Variation V, the key changes again, and the texture thins as the presence of dotted rhythms returns. In the original *Lied*, the vocalist sings about the dead trout in the same lively manner as at the beginning, but more importantly, the accompaniment returns to the lilting, water-like motif from the beginning. The Quintet follows suit exactly. The lilting theme from *Die Forelle* is hinted at in the piano part at m. 133 upon the arrival at the final variation. Only when every part has played the motif does the Quintet end.

What the “Trout Quintet” accomplishes through key signature and motif, the *String Quartet in D Minor* accomplishes through its harmony and its division of variations into sections. *Der Tod und Das Mädchen* is about a young woman’s conversation with Death, who welcomes her to sleep in its arms. The song is divided into two sections, the first representing the maiden, and the second section, beginning at m. 22, representing Death. It is important to note that Death’s theme encapsulates the song, serving as the piano prelude and the end of the piece, though then it ends in the major key. In short, Schubert interprets Death to be a calming presence, as indicated by Death’s theme ending as a major key instead of a minor key. Death as a non-menacing presence is actually one of Schubert’s most common interpretations.²⁴ Thus the positive portrayal of

²³ Weber, “Mass Culture,” 178.

²⁴ Dietrich Fischer-Dieskau, *Schubert’s Songs: A Biographical Study* (New York: Alfred A. Knopf, 1977), 85.

Death in the Quartet is a continuation of Schubert's *Lieder* style. In the Quartet, each repeated section serves the function of being either the maiden or Death, and each variation can be viewed as a conversation between the two. The first three variations, mm. 25–101, are busy in terms of number of notes and interaction of parts. This activity culminates at m. 76, when all four instruments are in rhythmic unison. This passage is aggressive, as indicated by the fortissimo marking and subsequent sforzandos on each beat in mm. 76 and 77. This feeling of aggression is alleviated immediately in the following variation, which changes keys and features instrumentation that is more reminiscent of a chorale. Ultimately the movement ends as it began, except at a softer dynamic and voiced in a higher register, thus signifying the maiden's welcome into Death's embrace. The inclusion of aggressive and chaotic variations to represent the maiden and her life, and the culmination in calmness are unique to the instrumental work. By rewriting *Der Tod* in this instrumental context, Schubert was actually able to improve on his original vocal interpretation.

Schubert was a master poetic interpreter, and he was able to make his *Lieder* embody the essence of a text. However, with growing political unrest, vocal music was no longer a safe medium. As a result, instrumental music's rising prevalence gave Schubert new opportunities to disseminate his *Lieder*. Despite the challenge of having no vocal line to advance musical meaning, Schubert was able to create not one, but two musical masterworks of interpretation. First came the second movement of the Piano "Trout" Quintet. After a few years, Schubert again used a movement of a larger instrumental work to showcase one of his own songs, and this time Schubert conveyed, through the new medium, not merely his original interpretation but an even more complex interpretation. Schubert may have composed instrumental music as well as *Lieder*, but it was his aptitude for poetic interpretation that served as the driving force behind his writing process.

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Artists' Statements

Stacey Marie Summers

Cthulhu: I started this charcoal drawing on grey paper while I was in my sophomore year at Methodist. I had the idea to combine my love of making art with my love of literature, attempting to render what I believe the authors of classic literature were trying to describe in their characters. This drawing was my first attempt, taking the haunting monster in “Call of the Cthulhu” by H.P. Lovecraft as my first portrait for the series. I applied the skills I had learned at MU and my imagination, creatively filling in where Lovecraft left a gap in the description, to come up with the final image. I am currently working on another piece for this series: drawing from life and using pastels, I am creating the White Witch from C.S. Lewis’s *The Lion, the Witch and the Wardrobe*. I have plans to keep going with other characters.

Walter Barnett

My work is an expression of who I am, what I believe, and how I view the world around me. I seek to create pieces that speak to me or respond to new challenges. As a graphic design artist, most of my work is made with a digital background. However, I aspire to be the best I can be in all mediums, whether I’m creating a logo, digital illustration, or painting, or working in any other medium. I want my images to inspire viewers to think critically and creatively, and to make up their own stories. Today’s culture plays a big role in what I create. I find life amazing and believe that it is our duty to sculpt our life into whatever we want and find creative ways to try to perfect that sculpture, realizing that our effort always leaves room for improvement. As a designer, I want to produce work that will be accessible to everyone. If I can move someone emotionally, mentally, or psychologically, it is all worth it.

World Crisis 1.2: I used Photoshop to combine an abstract watercolor painting with a photograph I found. The piece is meant to convey the feeling of distress in the world and the chaos we live in.

Self-portrait (Ball Is Life): This is a charcoal piece created from a photograph I made. I used dark shades and different techniques to show depth.

King Kong Movie Poster: This is one of my first digital illustrations. I used a Wacom tablet and Adobe Illustrator software. I wanted to emphasize the seriousness in King Kong’s eyes as he is comforted by a woman he has become obsessed with.

Octophant: For this piece I set out to combine two things that normally wouldn't be associated with one another: the creativity of the octopus and the wisdom and knowledge of the elephant. In executing this merger, I wanted to project a lively and energetic feel as well as suggest movement and creation/imagination.



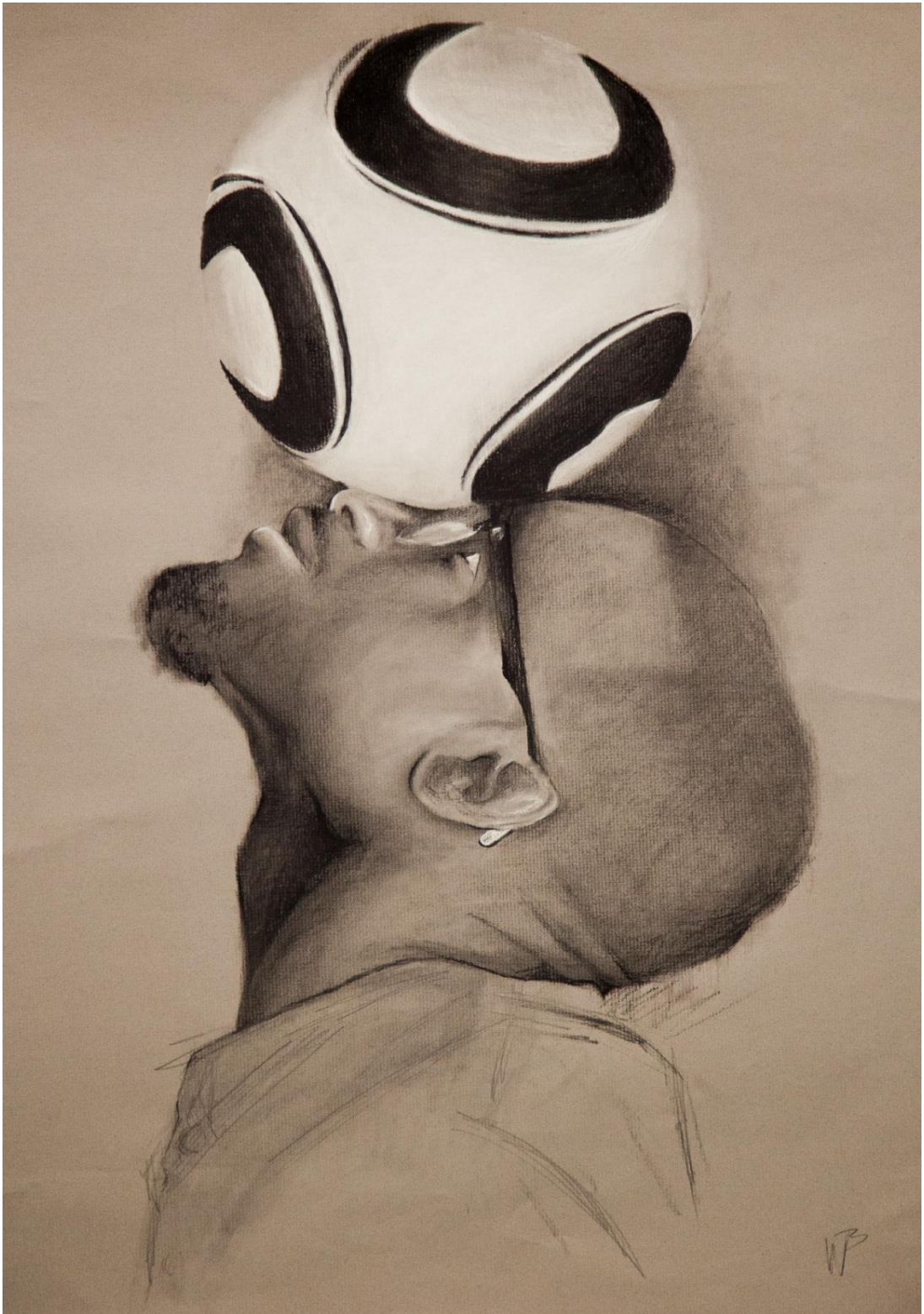
Stacy Marie Summers

Cthulhu



Walter Barnett

World Crisis, 1.2



Walter Barnett

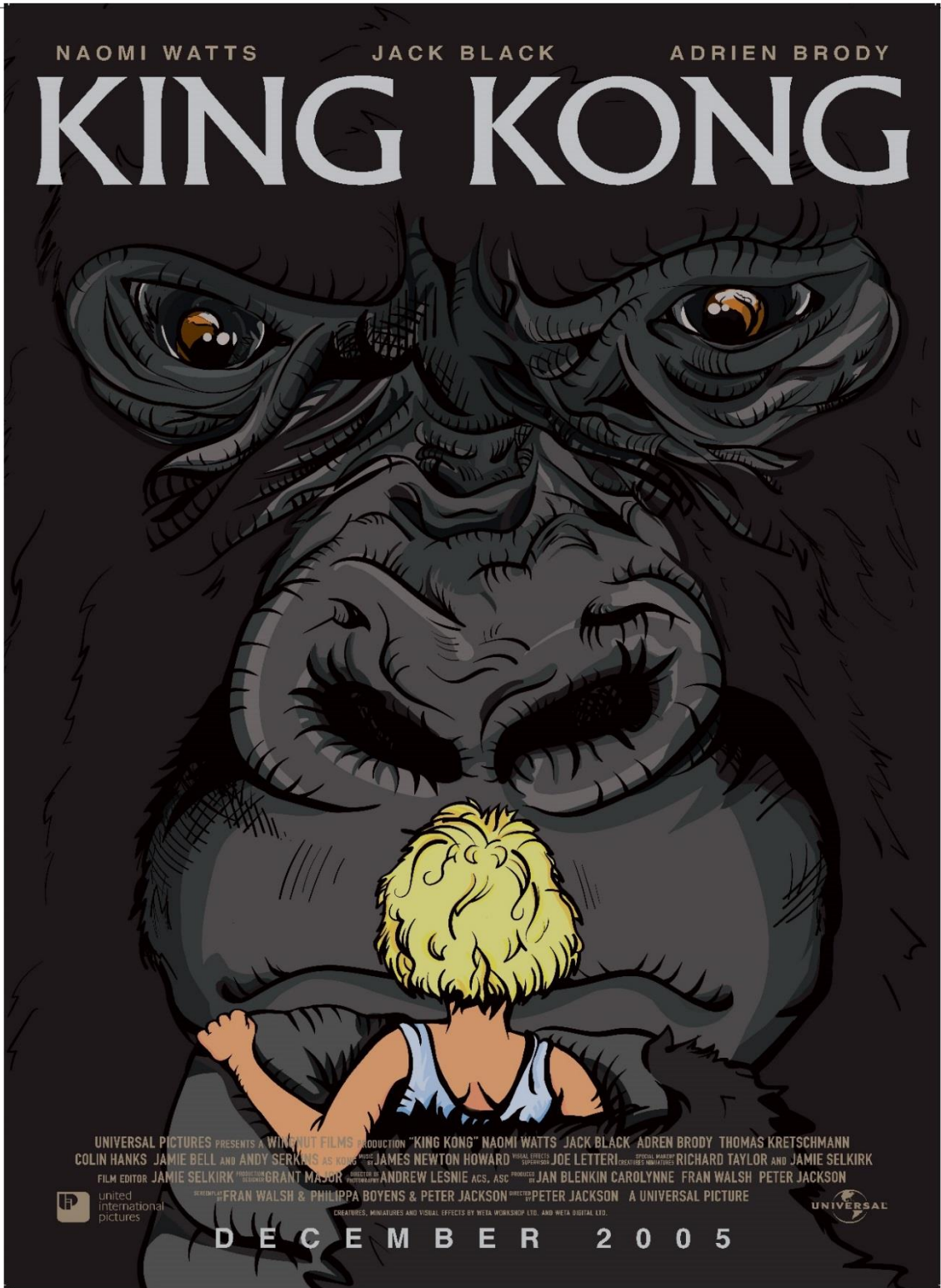
Self-portrait (Ball Is Life)

NAOMI WATTS

JACK BLACK

ADRIEN BRODY

KING KONG



UNIVERSAL PICTURES PRESENTS A WINGNUT FILMS PRODUCTION "KING KONG" NAOMI WATTS JACK BLACK ADRIEN BRODY THOMAS KRETSCHMANN
 COLIN HANKS JAMIE BELL AND ANDY SERKINS AS KONG COSTUME DESIGNER JAMES NEWTON HOWARD SPECIAL EFFECTS SUPERVISOR JOE LETTERI SPECIAL MAKEUP BY RICHARD TAYLOR AND JAMIE SELKIRK
 FILM EDITOR JAMIE SELKIRK PRODUCTION DESIGNER GRANT MASON EXECUTIVE PRODUCERS ANDREW LESNIE ACS, ASC PRODUCED BY JAN BLENKIN CAROLYNNE FRAN WALSH PETER JACKSON
 SCREENPLAY BY FRAN WALSH & PHILIPPA BOYENS & PETER JACKSON DIRECTED BY PETER JACKSON A UNIVERSAL PICTURE
CREATIVES, MINIATURES AND VISUAL EFFECTS BY WETA WORKSHOP LTD. AND WETA DIGITAL LTD.



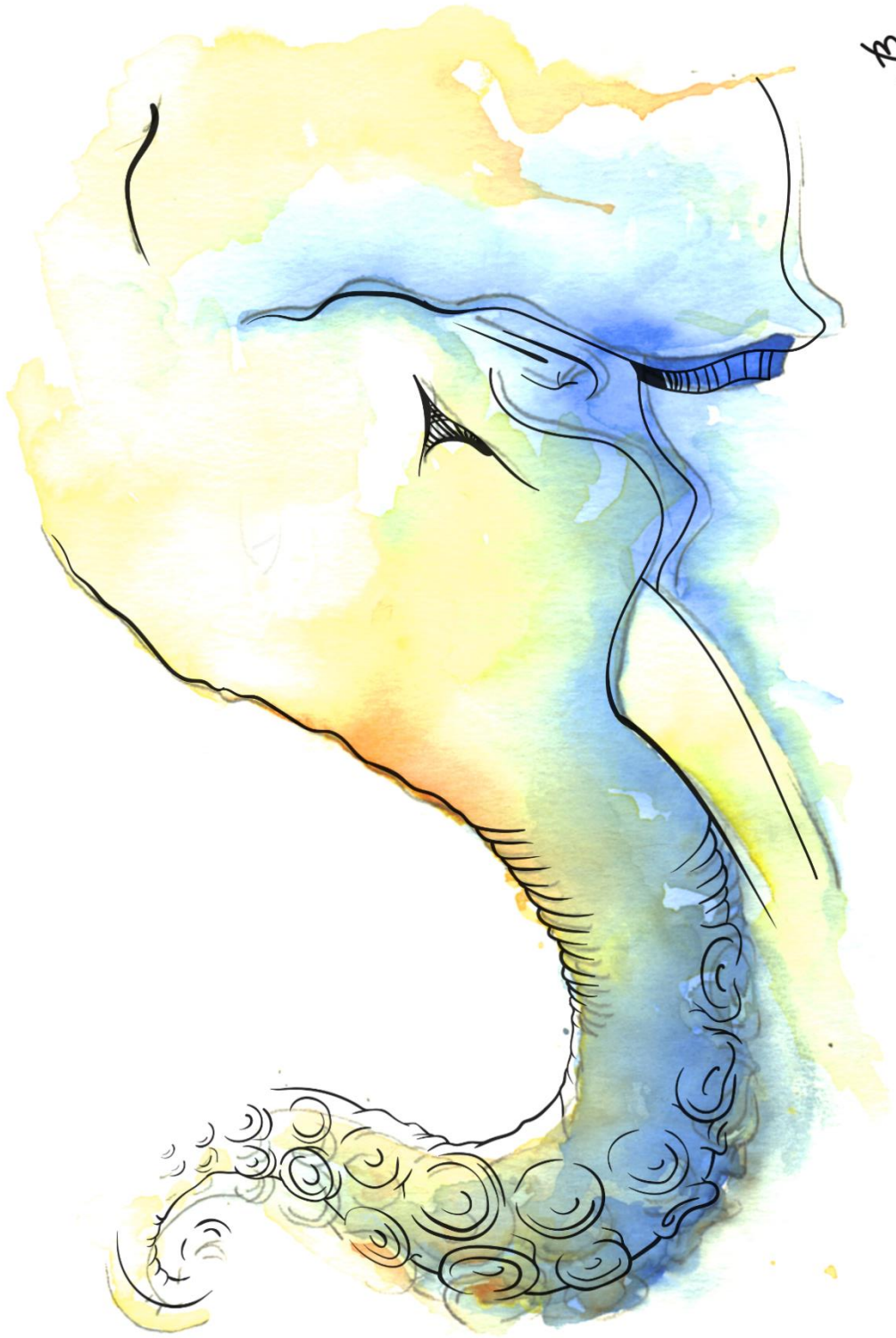
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DECEMBER 2005

Walter Barnett

King Kong Movie Poster



WB

Octophant

Walter Barnett

Teaching: The Job That Anyone Can Do?

Emily Ewin

Faculty Sponsor: Dr. Jennifer Broome

Department of Education

Introduction

America's public schools have suffered teacher shortages for decades (Simmons & Mebane, 2005). One of the ways states have sought to fill vacant positions is by creating multiple methods of becoming a licensed teacher. In North Carolina, one such method is lateral entry. Lateral entry refers both to an alternate route to becoming a teacher in North Carolina and to individuals hired to teach without formal teacher training. Lateral entry teachers have completed a bachelor's degree in a non-teaching field; they are often looking for a mid-career change (Douglas, 2011). Originally, lateral entry was designed to fill high-need positions in math, science, and technical courses for grades 9-12 (Dr. Jennifer Broome, Teacher Education Program, Methodist University in Fayetteville, North Carolina, personal communication December 10, 2016). However, the ongoing shortage of special education teachers in North Carolina means the state has turned to lateral entry teachers to fill this role. Special education teachers are those who teach children with special needs, also known as children with disabilities or exceptional children. While other states may use alternative licensure, they typically exclude elementary and special education positions due to the nature of this student population and its needs (J. Broome, personal communication December 10, 2016). North Carolina, on the other hand, has made lateral entry available across all ages and needs.

North Carolina's policy has engendered backlash from traditionally licensed teachers who feel the lateral entry option has negatively impacted students, especially students with disabilities (Douglas, 2011). Research indicates that students taught by a traditionally licensed special education teacher achieve more compared to students taught by a lateral entry teacher (Douglas, 2011; Montrosse, 2009; Wesson, 2008). This difference is partially attributable to differences in teacher training, especially training in special education. Strong evidence indicates that a lack of appropriate training in pedagogy and classroom management is a contributing factor to lateral entry teachers' reduced ability to competently teach special education students (Henry et al., 2014).

Literature Review

Teacher shortages have been a silent crisis across the United States for several decades. Researchers predict that as many as 2.4 million additional teachers will be needed during the next decade (Simmons & Mebane, 2005). Teacher shortages are attributed to factors such as rising student enrollments, increasing retirement of experienced teachers, state and federal initiatives to lower class sizes, and a high rate of teachers' resigning after their first year of teaching (Simmons & Mebane, 2005). The number of potential teachers is also decreasing. Undergraduate education programs are not attracting undergraduate students. Gregory Anderson, dean of the College of Education at Temple University in Philadelphia, states, "If I'm an undergraduate student... teaching as a profession is not necessarily one with shining possibilities" (as quoted in Boccella, 2016). North Carolina is experiencing this problem even more seriously due to rapid population growth (Simmons & Mebane, 2005). In 2006, North Carolina colleges and universities were only graduating 35% of the 7000 new teachers needed (Douglas, 2011). The severity of the shortage in North Carolina means that school system administrators hire outside the state and "approximately two-thirds of newly hired teachers each year come from outside North Carolina" (Simmons & Mebane, 2005, p. 46).



Children in a classroom, 1985, by Michael Anderson. Released by National Cancer Institute, part of the National Institutes of Health, ID 2200 (image). Public domain. https://commons.wikimedia.org/w/index.php?search=children+in+classroom&title=pecial:Search&go=Go&searchToken=3jic2x1r78jcnuyepbz8sqh0p#/media/File:Children_in_a_classroom.jpg

North Carolina put alternative routes to becoming a teacher in place during the 1960s when the teaching shortage was not as dire as it is today (Simmons & Mebane, 2005). In 1985, North Carolina enacted lateral entry to provide an alternate route for candidates to enter the teaching profession (Simmons & Mebane, 2005). The purpose of having alternate routes is to give qualified individuals with college degrees outside of education an opportunity to enter the teaching profession to help fill open teaching positions (Simmons & Mebane, 2005). Lateral entry was primarily used in secondary schools for specific content areas such as biology, algebra, or economics. As the teacher shortage became a major problem during the last two decades, North Carolina utilized lateral entry teachers in elementary and special education classrooms. Lateral entry has become increasingly evident over the last two decades; more than half of classroom teachers enter the profession through different routes than traditional teacher education programs (Simmons & Mebane, 2005).

Demand is not uniform across teaching specialties. In particular, secondary mathematics, science, and special education face the most severe shortages. Ninety-eight percent of the nation's school districts report being unable to hire enough licensed special education teachers (Montrosse, 2009). North Carolina specifically has struggled with maintaining special education teachers. According to the U.S. Department of Education "Teacher Shortage Areas Nationwide Listing," North Carolina had a shortage of special education teachers from 1993 to 2016 (Cross, 2016).

In the Individuals with Disabilities Education Act (IDEA), a child with disability is defined as one who has

autism, deaf-blindness, deafness, an emotional disturbance, a hearing impairment, mental retardation, multiple disabilities, an orthopedic impairment, an other [sic] health impairment, a specific learning disability, a speech or language impairment, a traumatic brain injury, or a visual impairment, and who by reason of his or her disability, needs special education and related services. (IDEA of 2004)

Not surprisingly, teaching such children presents numerous and varied challenges, and teachers who lack specialized training may not meet such challenges successfully.

Legislation

To attempt to attract qualified teachers who went through a traditional four-year program, the North Carolina General Assembly adopted the Excellent Schools Act in 1997 (North Carolina State Board of Education, 2016). The government's goal in passing this legislation was to increase student achievement, reduce teacher attrition, and reward teachers for knowledge and skills (NC State Board of Education, 2016). To decrease teacher attrition, the 1997 act aimed to raise teachers' wages and provide enhanced training. The act also raised state standards for teachers entering and staying in the profession. In response to this act, the State Board of Education developed enhanced requirements for continuing certification for teachers in the public school setting (NC State Board of Education, 2016). These requirements for teachers, known as performance-based licensure, require that all second-year teachers fulfill certain requirements prior to being issued a continuing license. The requirements include

submitting the following: lesson plans, a 15-minute video of their work in the classroom, portfolio entries in three different areas of content, and reflective writing on their experiences. To reward teachers for meeting the higher standards and for going through performance-based licensure, the 1997 Excellent Schools Act provided teachers with salary increases after teaching for three years (NC State Board of Education, 2016). However, these efforts were not successful to relieve the teacher shortage.

Lateral entry candidates must meet several requirements in order to qualify for a provisional teaching license. These standards include having a bachelor's degree from a regionally accredited college or university ("Lateral Entry Teachers," 2016). Then, candidates must meet at least one of the following requirements: relevant subject area degree, 24 semester-hours of coursework in the subject area with a letter grade of C or higher, or a passing score on the North Carolina State Board of Education approved licensure exams for the content teaching area. Additionally, candidates must meet at least one of the following qualifications: 2.5 cumulative GPA, five years of experience considered relevant by the employing local education agency, or passing scores on Praxis Core Academic Skills for Educators ("Lateral Entry Teachers," 2016). Lateral entry teachers need not have formal training in classroom management skills or in pedagogy (Douglas, 2011, p. 14).

Undergraduates who are enrolled in a traditional education program spend typically four to five years learning about pedagogy, classroom management, lesson planning, and implementation strategies (J. Broome, personal communication December 10, 2016). Additionally, undergraduates who are enrolled in an education program have to complete sixteen weeks of closely supervised student teaching in order to receive North Carolina licensure. Carol Davis Douglas's research indicates that lateral entry teachers in North Carolina only have to complete a two-week training prior to entering the classroom setting. The two-week mandatory training was very basic and was often completed as a self-study experience from computer programs; candidates were not placed in the classroom setting; and at no point during the training did candidates work with students (Douglas, 2011). The training of lateral entry teachers does not fully prepare them with classroom management and pedagogy skills, ultimately setting up the students of lateral-entry special education teachers to achieve less compared to students taught by a traditionally licensed special education teacher.

The value of teachers, and of their being highly qualified, was temporarily increased when the federal government enacted the No Child Left Behind (NCLB) Act. Having highly qualified teachers in the classroom became a point of emphasis on a national level with the NCLB Act of 2001 signed by President George W. Bush (Simpson, LaCava, & Patricia, 2004). The act established goals for both general education students and special needs students to meet state-identified standards (Simpson, LaCava, & Patricia, 2004). These goals made a huge impact on education as a whole by putting pressure on teachers to be held accountable for student success. The act's goal was for all children to receive a quality education (Franklin, 2010). Therefore, the federal government focused attention on how teachers taught and whether their instruction was effective for the students.

To meet the goal of giving all children a quality education, the government focused on teachers being highly qualified due to researchers' having identified a link between student achievement and highly qualified teachers (Simpson, LaCava, & Patricia,

2004; Wong, 2009). As a result of this research and the NCLB Act, the government became responsible to provide a free and appropriate education to all students. To ensure that students and teachers were meeting state standards, the government established “adequate yearly progress” (AYP) standards (Simpson, LaCava, & Patricia, 2004). Endorsing these standards benefited parents, community leaders, and school district personnel. It allowed these individuals the opportunity to identify student’s strengths and weaknesses through data in specific content areas. However, AYP standards were only measured by state standardized testing, not through student work samples or teacher-administered tests. NCLB ultimately put stress on the state of North Carolina to have qualified teachers in the classroom. The government was monitoring student success. However, the teacher shortage trumped the importance of having highly qualified teachers. North Carolina allowed lenience on certification qualifications to attract teacher candidates immediately.

Special education lateral entry teachers are not fully certified for at least the first three years of teaching (“Lateral Entry Teachers,” 2016). If candidates qualify for a lateral entry position, they will receive a lateral entry professional educator’s license. This is a temporary license that lasts for three years. During the first year of teaching, lateral entry teachers must attempt to pass the PRAXIS II and Pearson Tests. These tests are designed to see if candidates understand curriculum and content area. Also, these tests are required for traditional certified teachers as well. Typically, traditional teachers have completed and passed these tests prior to entering the classroom setting. The lateral entry candidates must pass PRAXIS II and the Pearson Tests before the second year of teaching (“Lateral Entry Teachers,” 2016). During the three-year period, lateral entry teachers have the option to seek a professional teacher’s license through regional alternative licensing centers (RALCs), which are located in different regions of North Carolina, or through coursework through a college or university. After the three-year period is over, if a candidate has not completed the coursework, then his/her license will expire. If a candidate does complete all coursework and pass the required tests, he/she will be recommended for a professional educator’s licensure by the college, university or RALC (“Lateral Entry Teachers,” 2016). The recommendations are then sent to the NC Department of Public Instruction, where they are evaluated (“Lateral Entry Teachers, 2016”). Typically, if candidates meet all requirements, they are issued a Professional Educator’s Continuing License (“Lateral Entry Teachers,” 2016).

Mindset of Some Lateral Entry Teachers

Research has defined highly qualified teachers as individuals who are fully certified and proficient in their specified content areas (Montrosse, 2009), but lateral entry teachers often begin teaching with little idea of what it takes to attain such proficiency. Carol Davis Douglas (2011) interviewed twelve lateral entry teachers over a five-year span, in order to track their feelings and perceptions as they began teaching and then gained experience in the classroom. Douglas interviewed all twelve lateral entry teachers before they entered their classrooms, at which time the non-traditional teachers expressed their universal opinion that teaching would be easy. Over the five-year span of Douglas’s study, these lateral entry teachers’ perceptions changed drastically.

Lateral entry teacher Dennis Hong expected teaching to be laid back. Prior to becoming a teacher, he was a molecular biologist. His workdays consisted of culturing viruses. When he changed his career to being a high school science teacher, he struggled with classroom management. Hong told Carol Davis Douglas, “[S]ometimes, my students get disruptive, and I swear to myself in frustration” (Douglas, 2011, p. 9). Hong was frustrated not only by his students’ conduct in the class, but also by his acquaintances when they asked how work was going. He would explain the difficult time he was having with students’ behavior. The responses he got were frustrating; people asked questions, such as “Have you tried making it fun for the kids?” Then, after the questioning, people typically explained to Hong how to do his job properly. At that moment, Hong realized how little respect teachers get. He admitted to having the same opinions prior to becoming a teacher. Hong’s ideas and thoughts about teaching have changed dramatically, as he stated,

Teaching isn’t just “making it fun” for the kids. Teaching isn’t just academic content. Teaching understands how the human brain processes information and preparing [*sic*] lessons with this understanding in mind. Teaching is simultaneously instilling in a child the belief that she can accomplish anything she wants while admonishing her for producing shoddy work. Teaching understands both the psychology and the physiology behind the changes the adolescent mind goes through... Teaching is not easy. Teaching is not intuitive. Teaching is not something that anyone can figure out on their own. (Douglas, 2011 p. 10)

Hong gained his new perspective the hard way.

Hong went on to reflect on how many people believe that anyone can do what the typical teacher does. Hong has observed numerous teacher candidates who have strong beliefs that they can teach better than a certified teacher. Hong stated a very important question: “What qualifies non-teachers as experts on how to teach when their only frame of reference is their experience as a student?” (Douglas, 2011, p. 11). Non-teachers do not spend four years learning methods, lesson plans, pedagogy, and classroom management as traditional teachers do. Hong’s beliefs before he began teaching and the outsider comments he reported show the general lack of understanding and respect for the teaching profession. Even though lateral entry teachers think they can teach better than traditional teachers, they struggle with their lack of the two main skill sets: pedagogy and classroom management.

Pedagogy

Dr. Juanita Heyward, an associate professor of the Education Department at Methodist University, defines pedagogy as “the art of the teaching, the way in which one teaches” (Dr. J. Heyward, personal communication November 18, 2016). Pedagogy is the skill of combining one’s knowledge with techniques for breaking down the information effectively for students. Teaching pedagogy is the essential mission of Methodist University’s Education Department. At Methodist University, traditional teacher candidates are taught, observed, and given the opportunity to reflect on the characteristics of a facilitative teacher (J. Heyward, personal communication November 18, 2016). The qualities of being understanding, knowledgeable, communicative, and

attentive are consistently reinforced through the professors' teaching of lesson planning, unit planning, classroom management skills, etc. Also, traditional teacher candidates are evaluated in the classroom setting, using a Likert scale, for their development of these qualities. In contrast, lateral entry teachers are not observed or critiqued on how they teach prior to entering the profession. Heyward articulates that, when a teacher candidate completes a traditional education program, they are prepared with techniques for assessing and analyzing students' knowledge (J. Heyward, personal communication November 18, 2016). Traditional teachers are taught how to build on students' skill sets and to individualize instruction (J. Heyward, personal communication November 18, 2016).

Students in exceptional children's programs—that is, programs for children with disabilities, children with special needs—have diverse and complex needs (Mintz & Wyse, 2015). In particular, students who have diagnostic labels, such as autism, dyslexia, or attention deficit disorder (ADD), and even exceptional children without a label typically do not respond to learning in a straightforward way (Mintz & Wyse, 2015). Due to their diverse needs, knowledge about how to teach different lessons is important. Traditionally educated teachers know how to do this through their comprehension of pedagogy, the art of teaching. Properly trained teachers use a variety of instructional techniques and engage students in ways specific to their individual needs. Research by Mintz and Wyse (2015) about inclusion of pedagogy found that teachers need to have an understanding of their students in order to teach proficiently. When teachers of exceptional children master pedagogy, they can design lessons specifically for student's individual needs and interests. Andrew Cardow and Robert Smith (2015) noted in "Using Innovative Pedagogies in the Classroom" that it is difficult to gain student interest in academic topics to which they have no personal connection. Cardow and Smith (2015) observed that teachers who implement pedagogy strategies in their lessons trigger a higher level of student interest, which correlates with student success. Therefore, if teachers are not trained in pedagogy, they can negatively affect a student's academic career.

The use of pedagogy was apparent in the study "Shifting Paradigms to Better Serve Twice-Exceptional African-American Learners" by Owens, Ford, Lisbon, and Owens (2016). The researchers studied a student known as Franklyn. The elementary school Franklyn attended established that he frequently demonstrated behavioral problems, including violent behavior. Franklyn's general education teacher referred him to be evaluated for special education services. The school decided that Franklyn met the qualifications for behavioral deficits, and he repeated the first grade. Throughout Franklyn's early educational career, he continued to have problems learning information and maintaining friendships. When Franklyn entered the fourth grade, he started working with Ms. Haile, a traditionally licensed special education teacher. Ms. Haile applied theories she had learned about giftedness to Franklyn (Owens et al., 2016).

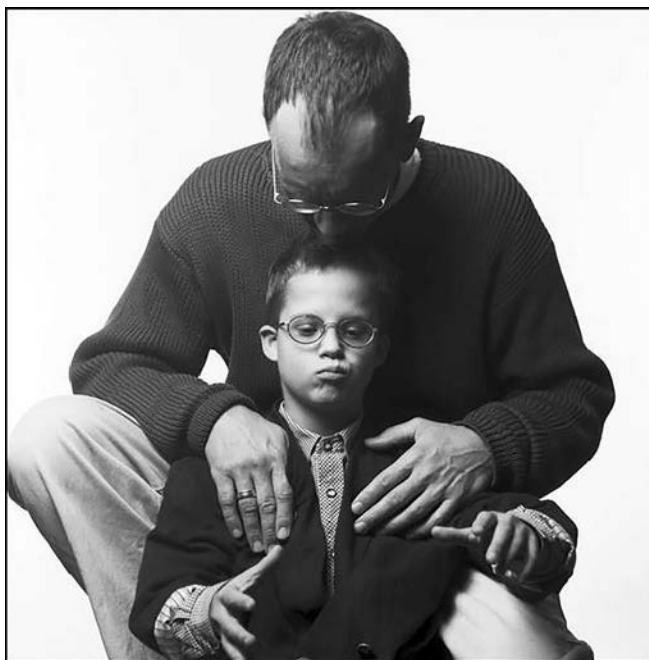
Ms. Haile noted that Franklyn loved processing and exploring. Additionally, he enjoyed sharing his discoveries with his peers and adults. Franklyn enjoyed challenging others to see concepts a different way. Franklyn's thinking was typically "out of the box" and clever. Ms. Haile noted all these characteristics and analyzed them, instead of focusing on Franklyn's emotional and behavior problems. Ms. Haile correlated Franklyn's actions to being gifted in creative and cognitive domains. She extended his learning through individual research projects and displayed his discoveries throughout the

school. She additionally utilized the individualized behavior plan created by the school in the general education classroom. These tactics made him approachable to his peers, which helped decrease emotional and behavioral problems in the school setting. Over a period of numerous weeks, Franklyn increased his academic performance in both the general and special education setting. Furthermore, the severity of his negative behavior decreased. By using pedagogy in her teaching, Ms. Haile was able to successfully identify Franklyn as gifted. This ultimately guided Franklyn to become successful in school. Without Ms. Haile, it is unclear what Franklyn's academic future would have been (Owens et al., 2016).

Typically lateral entry teachers lack knowledge of pedagogy. Research by Wesson (2008), reported in "The Dispositions in Action of Lateral Entry and Traditionally Certified Elementary Teachers in North Carolina," analyzed the classroom skills of three lateral entry and three traditionally certified teachers. Wesson (2008) specifically analyzed the domains of classroom management, instruction, and assessment. His research found many examples of lateral entry teachers' lack of competence in pedagogy. While analyzing lateral entry teachers, Wesson (2008) noted that they typically utilized direct instruction worksheets and textbooks (p. 81). These methods are not appropriate when teaching students who may have visual and hearing impairments, traumatic brain injury, dyslexia, dysgraphia, and other disabilities. In utilizing work sheets and lectures, lateral entry teachers are not considering who the students are and how they need to be taught, which

correlates to pedagogy. Lateral entry teachers do not know about pedagogy because they never receive formal pedagogical training, unlike traditionally trained teachers (Douglas, 2011, p. 30). Their teaching techniques reveal a rigid style of teaching that fails to meet their students' diverse needs.

Additionally, Wesson (2008) noticed that traditionally licensed teachers demonstrated varied and personalized instructional strategies. The traditionally licensed teachers exhibited different types of dialogues and interactions throughout teaching their lessons (p.109), while in comparison lateral entry teachers used technical language that was not personalized. In their book, "The First Day of School:



Father with Son Who Has Down's Syndrome, 2017, by Andreas Bohnenstengel. Creative Commons Attribution-Share Alike 3.0 Germany license. https://commons.wikimedia.org/wiki/File:Vater_und_Sohn_mit_Down-Syndrom.jpg

How to be an Effective Teacher,” Wong and Wong (2009) state that, in order to teach mastery, an effective teacher must know how to design lessons in which a student will be able to learn a concept or skill. Lateral entry teachers lack knowledge of how to design effective lessons. This ultimately impacts the quality of a student’s education. Teacher quality is directly correlated with student achievement (Wesson, 2008). Lateral entry teachers’ lack of knowledge of pedagogy will compromise student success (Wesson, 2008).

Besides knowing how to write and implement effective lessons, special education teachers also must have knowledge about all the laws and procedures that are in place for exceptional children. Lateral entry teachers entering the field of special education often do not possess all this knowledge. The federal Individuals with Disabilities Education Act (IDEA), passed in 1975, covers children from birth to young adulthood and entitles them to receive a free appropriate education (Lipkin & Okamoto, 2015). IDEA has several key requirements to help bolster development and learning for students with disabilities (Lipkin & Okamoto, 2015). One crucial part of IDEA is an individualized learning plan (IEP); special education teachers typically write these documents.

Traditional special education teachers receive training in writing IEPs during a four-year college education program. The IEP states a student’s specific educational and service needs. Additionally, while constructing this document, parents or legal guardians—and when appropriate the student—are allowed to provide input on what specific services are necessary for the student (Montrosse, 2009). Another key part of IDEA is the “least restrictive environment” (LRE); the principle of LRE is that students with disabilities receive their education in the most appropriate setting. Different classroom settings can include self-contained classrooms and the mainstream setting. A self-contained classroom is only for students who have exceptional needs. In contrast, mainstreaming means placing a student with special needs in a general education classroom for part or most of the school day. The special education teacher and parent determine the placement of the student (Lipkin & Okamoto, 2015).

If the special education teacher lacks knowledge about what LRE is, that ignorance can negatively affect a student’s education. Pedagogy is not just having knowledge: teachers demonstrate pedagogy by knowing how to implement procedures and strategies. Pedagogy is what lateral entry teachers lack. According to the twenty-fifth Annual Report to Congress on the Implementation of the IDEA, North Carolina had a higher incidence of exceptional children compared to national averages (Montrosse, 2009). The higher proportion of such students emphasizes North Carolina’s need to secure highly trained teachers of exceptional children.

Classroom Management

Knowledge of pedagogy must be matched by classroom management skills. In Carol Davis Douglas’s interviews and research, she found that many lateral entry teachers did not think about or complete a classroom management plan for their first year of teaching (Douglas, 2011). In Douglas’s interviews of twelve lateral entry teachers over a five-year span, almost all these teachers agreed that managing students was difficult. Nine out of twelve lateral entry teachers stated that handling students’ behavior and deciding discipline were among the hardest tasks (Douglas, 2011). One interviewee in

particular, Dennis, stated prior to entering his first year of teaching that “I think my biggest obstacle will be classroom management” (Douglas, 2011, p. 69). Dennis taught in the middle school setting with students on all different levels. It is unclear if Dennis had exceptional children in his classes or not. Dennis expressed his confidence in being able to teach the content due to his prior knowledge of the North Carolina curriculum. To survey Dennis’s feelings towards his new career choice, Douglas asked him to rank his enthusiasm. Dennis responded with the rating of nine. Additionally, she asked what his anxiety level was and he responded with a six. At the end of Dennis’s first year of teaching, Douglas asked him again to rate his enthusiasm about teaching on a scale of one to ten, and his response was three (Douglas, 2011). Furthermore, she asked about his frustration level and he responded “a 9 to a 10” (Douglas, 2011). If Dennis had thought about a classroom management plan, his frustration with his class could potentially have been eliminated. Traditional teachers who are enrolled in a four-year program learn about classroom management plans and different discipline strategies. The literature available on how to manage classes effectively is typically not given or recommended to lateral entry teachers by administrators (Douglas, 2011). This is due to public school officials’ failure to comprehend that these lateral entry teachers lack classroom management knowledge. In traditional education programs, teacher candidates learn how to implement classroom management strategies.

Methodist University’s Education Department requires traditional teacher candidates to take a course known as “Seminar in Positive Behavior Development.” In the course students use the textbook *The First Day of School: How To Be an Effective Teacher* by Harry K. Wong and Rosemary T. Wong (2009). This textbook covers the Wongs’ research on how to be an effective teacher. One concept the Wongs discuss is knowledge and implementation of classroom management. Dr. Harry Wong defines classroom management as “the practices and procedures that allows [*sic*] teachers to teach and students to learn” (Starr, 2005). In their research, the Wongs have discovered that classroom management has a huge impact on student achievement.

Having classroom procedures in place facilitates proficient activities and lessons. Classroom procedures can include bell work, how to enter and exit the classroom, taking out and retrieving supplies, what to do with unfinished work, and when and how to take care of bodily functions (Wong & Wong, 2009). These behaviors often appear to be common knowledge, and it would seem the students should know how to conduct themselves in a classroom. But the Wongs’ research has shown that students do not have awareness of what teacher expectations are until they are directly taught (Wong & Wong, 2009). Teachers must explain their personal expectations and the procedures of a classroom on the first day of school, and be consistent when implementing these practices. This is especially important in a special education setting due to exceptional children needing more structure and routine compared to students in a general education setting. Lateral entry teachers’ ignorance of these ideas negatively affects their classroom management and their students. Douglas’s study with the lateral entry teacher Dennis demonstrates the cost of a lack of classroom management skills. Furthermore, a common misconception is that classroom management is discipline. As stated in the Wongs’ (2009) textbook, *The First Day of School: How To Be an Effective Teacher*, “discipline concerns how students behave. Procedures concern how things are done” (p. 19). If the interviewee Dennis from Douglas’s study had had knowledge about classroom

management, it is possible his perspectives and attitudes about the career of teaching would have been different.

Conclusion

The teaching profession is often thought of as the occupation that anyone can do. For an emerging teacher, that view can be particularly troubling. The State of North Carolina instituted lateral entry hiring to put teachers in the classroom but, without the requisite qualifications, lateral entry teachers place their students—especially the diverse learners or exceptional children—at a disadvantage with long-term consequences.

Lateral entry teachers typically utilize basic instructional techniques rather than proven effective methodologies, and this cannot be easy for them. Ultimately, lateral entry teachers' two-week training period does not incorporate the necessary preparation, experience, and skills to ensure the success of future teachers of exceptional students. This glaring disservice harms both the teachers and the students, but it is the children—who cannot compensate for the resulting educational shortcomings—who are most negatively impacted. North Carolina's policy of hiring lateral entry teachers for exceptional children is fundamentally flawed.

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Ectoparasitic Skin Diseases of Two-toed and Three-toed Sloths in Costa Rica

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Abstract

A total of 16 sloths in the wild and in captivity (eight *B. variegatus* and eight *C. hoffmanni*) were evaluated for dermatitis over a two-week period in Manuel Antonio, Costa Rica. Fungal culture, skin impression, and skin scrapings were conducted on each individual case in order to follow the differential diagnostic minimum database of small animal dermatology. Captive population samples were taken from a wildlife sanctuary and The Sloth Institute Costa Rica rehabilitation facility. A definitive diagnosis was not possible in five of the cases. In the captive population (six *B. variegatus* and five *C. hoffmanni*), dermatophytosis by *Microsporum gypseum* was detected in three *C. hoffmanni* adults (18.7%), sarcoptic mange in three pruritic *B. variegatus* infants (18.7%), and pyotraumatic dermatitis in one adult *C. hoffmanni* (6.2%). Zoonotic ectoparasites were found exclusively in the captive sloth populations at the wildlife sanctuary. Five sloths from the wild presented with skin lesions: electric shock trauma from telephone wires was the primary cause of 80% of these lesions, and secondary *Malassezia* dermatitis (6.3%) and pyotraumatic dermatitis (12.5%) were confirmed with skin impression. The general trends of the trial indicate that the most prevalent cause of dermatitis was zoonotic ectoparasites (37.5%). Proper management and increased biological security in captive populations may contribute to the prevention of disease transmission.

Introduction

Bradypus variegatus and *Choloepus hoffmanni*, respectively known as the three-toed and two-toed sloths, are inhabitants of tropical rainforests of the Caribbean and Pacific regions of Central and South America (McCarthy et al. 1999). Sloths are primarily arboreal mammals and belong to the taxonomic order Pilosa. According to the Red List of Threatened Species published by the International Union for Conservation of Nature and Natural Resources (IUNC), nearly half of the genera belonging to the family Bradypodidae are recognized as critically endangered, with decreasing population trends. *C. hoffmanni* shares the phylogenetic family Megalonychidae with one other sloth species, *Choloepus didactylus*. Though *C. hoffmanni* and *B. variegatus* are currently listed as two species of least concern (IUNC 2016), their future survival is threatened by trends of

rapid deforestation and human encroachment on their natural habitat (Laurence et al. 1999, Sibaja-Morales et al. 2009).

Serving as a pilot study for development of a record of ectoparasitic infections among Costa Rican sloths, the current research uses the dermatologic testing minimum database to enable identification of specific ectoparasitic organisms in the subject population of 16 sloths, some captive and some wild. The results support the proposition that zoonotic ectoparasites—parasites that can be transmitted from animals to humans—are the most common cause of dermatitis in captive sloths and thus that proper management and increased biological security in captive populations are desirable to prevent disease transmission in both human and animal populations.

Habitat Loss & Fragmentation

During the 1960s and 1970s, Costa Rica experienced some of the highest rates of population growth and of deforestation in the world (Bixby and Palloni 1998, Sader and Joyce 1988). Habitat loss and fragmentation threaten sloth survival as they not only displace the sloths from their appropriate niche but also subject the species to a vast array of physiological stressors they would not experience in the wild. The Costa Rican government has promoted ecotourism to preserve the deteriorating tropical landscape of Costa Rica, but its policy has several limitations (Langholz et al. 1999). By definition, ecotourism enables travelers from around the world to experience the natural forest and wildlife while inflicting minimal human impact on the native ecosystems. Yet studies analyzing the mechanisms by which tourism of the tropics is developed, operated, and organized indicate that current practices allow for negative impact on the maintenance of overall healthy ecosystems (Isaacs 2000).

Over the last two decades, sloths have become an increasingly popular attraction to travelers in Central America. Young sloths are often captured and taken from their mothers in the wild, and held captive in improvised shelters; here they are sold to international travelers (Moreno and Plese 2006). Both buyers and sellers of the sloths are often unaware of the specific dietary needs of the animal, resulting in the surrender of extremely malnourished individuals to rehabilitation facilities. Of the 102 sloths intercepted by officials from traffickers in 2004, only 23 sloths were able to survive rehabilitation—13 of the 81 *B. variegatus* (16%) species and 10 of the 21 *C. hoffmanni* species (48%) (Moreno and Plese 2006).

Clinical Disorders

Sloths are becoming increasingly vulnerable to disease as urbanization and ecotourism introduce direct pathways for infectious organisms that are uncommon in the wild. As wild habitats shrink and wild sloths are captured, not only are sloths exposed to unfamiliar parasites and other organisms carried by domestic animals, but also their immunocompetency is compromised by the stresses of urban hazards and inappropriate diets. Prevalent clinical disorders recorded among both species are nutritional disorders (45.7%), digestive maladies (12.3%), respiratory complications (12.3%), and injuries (6.1%) (Diniz and Oliviera 1999). One case of habitat destruction resulted in the displacement of nearly 600 sloths to grasslands and beaches, where they suffered from starvation, dehydration, and parasite infection (Moreno and Plese 2006). Common physical injuries reported after the habitat disturbance included vehicle-induced

trauma, stoning by children, and electrical shock from telephone wires (Moreno and Plese 2006). A health survey of 277 sloths conducted at the Unau Foundation in Central America indicated that human-induced traumas, such as nail mutilation, filed down teeth, contusions, burns and other wounds, accounted for 2% of the sloth injuries treated, all of which increased the sloths' susceptibility to secondary bacterial infection (Moreno and Plese 2006).

Sloth pelage, or fur, shares a symbiotic relationship with diverse algal communities and plays an important role as a vector for several non-pathogenic arthropods (Gilmore 2001, Suutari et al. 2010). It has been suggested that these symbiotic relationships not only play an important role in camouflaging sloths, but also serve as source of nutrition via cutaneous absorption and diffusion along the hair shafts (Gilmore et al. 2001). Skin diseases that occur as a result of injury and uncommon parasitism disrupt these mutualistic relationships and are associated with 35% of nutritional and digestive illnesses (Diniz and Oliviera 1997). Hindrances to the symbiotic relationships between algal communities and pelage, as a result of dermatitis, can have hazardous effects on important physiological processes of both sloth species.

Dermatitis: Transmission and Manifestations

Dermatitis is a general term used to describe inflammation of the skin caused by allergens, disease, or infection. Lesions caused by physical injuries are the primary cause of secondary bacterial skin diseases in mammals; these diseases include pyotraumatic dermatitis, superficial pyoderma, and deep pyoderma (Diniz and Oliviera 1999, Hnilica, 2006). Since individuals with differing secondary bacterial skin diseases experience similar symptoms, each case must be investigated thoroughly to determine the appropriate therapy. Pyotraumatic dermatitis is characterized by an acutely pruritic, rapidly enlarging area of alopecia and erosive skin with moist exudate (Hnilica 2006). In contrast, both superficial and deep pyoderma involve hair follicles and adjacent epidermis, resulting in individuals presenting with multifocal or generalized areas of papules, epidermal collarettes, localized alopecia, and erythema (Hnilica, 2006, Wilson and Chen 2004).

Secondary fungal infections can also result from skin damage caused by chronic trauma and moisture (Hnilica 2006). Malasseziasis, more commonly known as yeast dermatitis, presents as nonhealing, erythematous, crusted skin or nail bed lesions (Black 2012, Hnilica 2006). Wounds must be treated immediately to avoid these bacterial and fungal skin diseases that ultimately hinder the sloth's mobility and ability to feed (Diniz 1999). Pyotraumatic dermatitis and *Malassezia* dermatitis are considered to be non-zoonotic infections, which indicates these diseases cannot be spread from animals to humans.

In contrast, sarcoptic mange is a highly contagious skin disease caused by the zoonotic arthropod itch mite, *Sarcoptes scabiei*. A study analyzing infectious diseases in the human population of international travelers stated that skin disorders are the third most common health ailment globally at 8% (Wilson and Chen 2004). Of the skin lesions present in travelers, arthropod-related dermatitis constituted 9.7% of disease found in persons seen at tropical disease medical units over a three-year period (Wilson and Chen 2004). The mite is highly transmissible due to its utilization of both animals and humans as carriers and its ability to infect by skin-to-skin contact between individuals (Black 2012, Diaz 2006). Infestation of humans from the animal mange is generally self-limiting

because the species of mite that infects animals is only able to reproduce on its specific host (Bandi and Saikumar 2013, Walton 2007). *S. scabiei* infestation on both the animal host and human reservoir presents as lesions, including papules, alopecia, erythema, crusts, and excoriations (Black 2012, Diaz 2006, Hnilica 2006). Lesions formed by hypersensitivities to the by-products of the animal mange mite lead to secondary bacterial infection; therefore, differential diagnosis is crucial to the overall health of the animal host.

Dermatophytosis (ringworm) is a zoonotic fungal infection of the hair shafts caused by keratinophilic fungi from the genera *Microsporum*, *Trichophyton*, and *Epidermophyton* (Xavier et al. 2006). Unlike yeast dermatitis, dermatophyte organisms are transmitted through direct contact with fur and dandruff that contain fungal particles, originating from an infected animal or environment. Skin involvement in both humans and animals may be localized or generalized with areas of circular, irregular, or diffuse alopecia with scaling. Other symptoms include erythema, papules, crusts, seborrhea, and onychodystrophy of the digits (Hnilica 2006).

Differential Diagnosis

The dermatologic diagnostic minimum database includes skin scrapes, cutaneous skin cytology/impression, and fungal cultures (Hnilica 2006). Differential diagnosis is crucial to determine the primary cause of a skin disease since lesions appear similar; however, these diseases can also co-occur and require different methods of treatment. As discussed in detail below, published research has not applied these differential diagnostic standards, possibly resulting in the publication of false-negative findings.

Over a one-year period, 65 Costa Rican sloth species from Sau Paulo Zoo were examined for gastrointestinal parasites and ectoparasites. The study concluded that 27 sloths presented with pruritic lesions, erythema, and hair loss, and were positive for *S. scabiei* itch; no evidence of fungal infection was found (Sibaja-Morales et al. 2009). Though Sibaja-Morales and colleagues' study was the first to discover that captive sloths can be infected with sarcoptic mange, it is of concern that no diagnostic test other than skin scraping was documented. The diagnosis was further supported when four researchers developed rashes after handling infected sloths (Sibaja-Morales et al. 2009). Nonetheless, this method raises several questions for concern, as the accuracy of skin scrapings is less than 50 percent when no other diagnostic test is performed (Hnilica 2006, Walter 2011).

An additional study in South America discovered that 100% of fungal cultures taken from sloths that presented with skin lesions tested positive for dermatophytosis from the genera *Microsporum* (Xavier et al. 2006). The researchers in this study did not perform additional skin impression and skin scraping tests, which fails the standard of differential diagnosis in small animal dermatology. Such incomplete protocols can lead to ineffective treatments with hazardous effects not just on the animal's health but also on the validity of statistics for future research.

Research pertaining to *B. variegatus* and *C. hoffmanni* ectoparasitic diseases is a relatively new field. While a few studies have investigated the presence of clinical diseases in sloths—and incorporate a brief synopsis of dermatological illnesses—the researchers have not conducted differential diagnosis of skin diseases, whether in wild or captive

animals (Diniz and Oliviera 1999, Moreno and Plese 2006, Sibaja-Morales et al. 2009, Xavier et al. 2007).

The objective of the present research is to serve as a pilot study to aid in establishing a recorded foundation of ectoparasitic infection incidence in sloths across various environments in Costa Rica by utilizing the dermatologic testing minimum database. The hypothesis of this study is that zoonotic ectoparasites are the primary cause of dermatitis in both captive and wild sloth populations in Costa Rica. The data collected throughout this experiment can be utilized in future long-term studies investigating the primary cause of skin diseases. Furthermore, an increased frequency of zoonotic parasite infection would indicate the need for establishing preventive measures to avoid further transmission in both the human and animal populations.

Materials and Methods

Location

Differential diagnostics were conducted on sloth species *C. hoffmanni* and *B. variegatus* residing in the wild and in captivity over a two-week period in Manuel Antonio, Costa Rica. Samples from captive specimens were obtained from two separate facilities. The first facility, a wildlife sanctuary, is located 7 km outside Quepos Central. The sanctuary is open three hours daily (0900-1200) to the general public for wildlife tours. Sloths are separated by age and placed in either the nursery or exhibition enclosure. The nursery is a solid studio structure that serves as housing for infant and juvenile sloths of both species. The adult *C. hoffmanni* sloths are held in a steel wire exhibition enclosure (6 x 6 x 6 m), as there are no adult *B. variegatus* individuals. The second sampling site, the Sloth Institute Costa Rica (TSI), located in Manuel Antonio, is a research facility that rehabilitates and reintroduces sloths into the wild. TSI houses *B. variegatus* and *C. hoffmanni* adult individuals that are held in enclosures (6 x 6 x 6 m) divided by steel fencing for separation of the species. Sloths are in direct contact with trained research professionals for approximately one to two hours daily, and the enclosures are not accessible to the general public.

Skin Scraping: Technique and Interpretation

Superficial skin scrapes of the sloth lesions were taken by applying moderate pressure with a dulled No. 10 sterile scalpel blade in the direction of hair growth on the affected area. Hair and debris collected on the blade were then transferred to a standard microscope slide prepared with three drops of veterinary grade mineral oil at the surface. Slides were examined microscopically under 400x total magnification to visualize superficial ectoparasitic mites. *S. scabiei* can be identified based on the presence of a long, unjointed pedicel with a sucker, on the end of the extremities (Hendrix 2007).

The ideal depths for skin scrapes depend on the organism in question (Hendrix 2007, Hnilica 2006); therefore, secondary skin scrapes were required. Secondary samples were taken in order to expel mites from deep within the hair follicles. Mineral oil was applied to the affected area, which was then scraped repeatedly in the direction of hair growth until the skin appeared pink, with the capillaries visible and oozing blood (Hendrix 2007, Walton 2007). False-negative findings can result if the deep skin scraping fails to provide a small amount of blood due to an increased potential for mites to be left

within the follicle. The deep skin scrape samples were examined under 400x total magnification for hair follicle mites (*Demodex* spp.).

Skin Impression: Technique and Interpretation

Secondary bacterial infection and *Malassezia* dermatitis prevalence or absence were evaluated utilizing acetate tape preparations of superficial samples. The acetate tape preparation technique involves the use of transparent adhesive tape to collect a sample of hair or superficial skin debris. The adhesive side of the tape was applied repeatedly to the lichenified lesions and processed with VetOne Rapid Differential Stain #3 (methylene blue CAS 1120-79-3, phosphate salts CAS 7778-770) for 30 seconds. The tape was rinsed for five seconds with deionized water, placed on a microscope slide, and examined under 1000x total magnification to visualize the presence or absence of bacteria and yeast (*Malassezia*) outgrowth.

The cytology of skin taken from sloth individuals with pyotraumatic dermatitis revealed the presence of mixed bacteria, whereas *Malasseziasis* was confirmed by the finding of several round to budding yeasts (Hnilica 2006). The bacteria in this technique are described based on morphology and not identified to species level.

Fungal Culture: Inoculation, Incubation, and Examination

Hardy Diagnostics Derm-Duet™ II*, RSM™/DTM, 15x100 Biplate, 15ml/15ml, individually wrapped Bacti-Lab Culture System™ was used to isolate and identify dermatophyte organisms. This culture plate has two sections: DTM and RSM. Dermatophyte fungal contaminant growing on DTM plates forms alkaline products that change pH indicators in the medium from yellow to deep red. The RSM produces a blue color change in response to a dermatophyte organism and also expedites the sporulation of macroconidia. The two-section plate is equipped with an antibacterial and antifungal compound that prohibits the growth of saprophytic fungi and bacteria contaminants; however, bacteria are not completely suppressed and some non-dermatophytic fungi can cause a false-positive red (DTM) or false-positive blue-green (RSM) color change.

Lesions were scraped with a No. 10 sterile scalpel blade and transferred by rubbing the broad side of the scalpel blade directly onto the agar surface of the plate. Plucks of hair were taken from the diseased area with a hemostat and the resulting specimen was tapped gently into the surface of the media. Cultures were stored away from light, lid-side down, at 25° C for 10 days. The media were examined every 48 hours during the incubation period for characteristic color change and colony appearance. Cultures that exhibited color change on the RSM or DTM on the 10th day of incubation were examined microscopically.

A microscope slide was prepared with one drop of VetOne Rapid Differential Stain #3 (methylene blue CAS 1120-79-3, phosphate salts CAS 7778-770). Acetate tape preparation was then used to collect conidia from the RSM segment and placed adhesive side down on the prepared slide. The slide was examined for spores under 400x total magnification. Dermatophytes and saprophytes were identified down to species level with identification charts provided by Bacti-Lab Skin Culture Systems™. Microscopic examination of fungal contaminants eliminated false-negative/false-positive results based solely on color change and colony morphology.

Results

General Overview

A total of 16 sloths were evaluated for dermatitis over a two-week period. Eleven sloths in captivity presented with dermal illness, 37.5% of which was attributed to zoonotic ectoparasite infection (Table 1). Zoonotic ectoparasites were found exclusively in the nursery and adult exhibition populations at the wildlife sanctuary. Five sloths from the wild presented with skin lesions: 80% of these lesions were attributed to electric shock trauma; three of the lesions had evidence of secondary bacterial infection (18.7%) and *Malassezia* overgrowth (6.3%).

Table 1. Dermatological Diseases in Captive & Wild Sloths.

Dermatitis	n (%) *	Cause (n)
Bacterial	4 (25.0)	Bite wound from non-pathogenic ectoparasite (1), Electric shock traumas (3)
Yeast	1 (6.3)	<i>Malassezia</i> overgrowth from electric shock trauma (1)
Zoonotic	6 (37.5)	<i>Sarcoptes scabiei</i> mange (3), <i>Microsporium gypseum</i> dermatophytosis (3)

*Five cases with inconclusive test results constitute 31.2% of the lesions not formally diagnosed.



Figure 1. *S. scabiei* infection. **A**, Pruritic *B. Variegatus* with mange. **B**, Presence of *S. scabiei* mite under 400x total magnification after superficial skin scraping. Photographs by author.

Captive Juveniles

Three *B. variegatus* juveniles from the wildlife sanctuary presented with pruritic lesions, and *S. scabiei* mites were confirmed post skin scraping (Figure 1). Skin impressions of the three individuals were negative for secondary bacterial infection and *Malassezia* overgrowth. Lack of blue color change on RSM agar indicated the absence of dermatophyte growth, which was confirmed with microscopic examination of fungal conidia on the 10th day of incubation.

Captive Exhibition Adults

Three *C. hoffmanni* exhibition adults presented with lesions at the wildlife sanctuary. The first case involved a male sloth, estimated to be one year old, with lesions present on four limbs, measuring 4 x 2 cm on left lateral metacarpal, 2 x 3 cm on the ventral aspect of the metatarsal, and 4.5 x 2 cm the right rear carpus (Figure 2). A 10-month-old female presented secondarily with bisymmetrical alopecia measuring 4 x 2 cm on the right and left metacarpals. The third and most severe of the cases was an approximately one-year-old male with lesions on stifle joint, elbow, lateral aspect of the antebrachium, and both carpi. Measurements of lesions were not obtained in this case due to the individual's aggressive behavior. Lesions were flaky, erythematous, and non-exudative, and had no callouses formed.

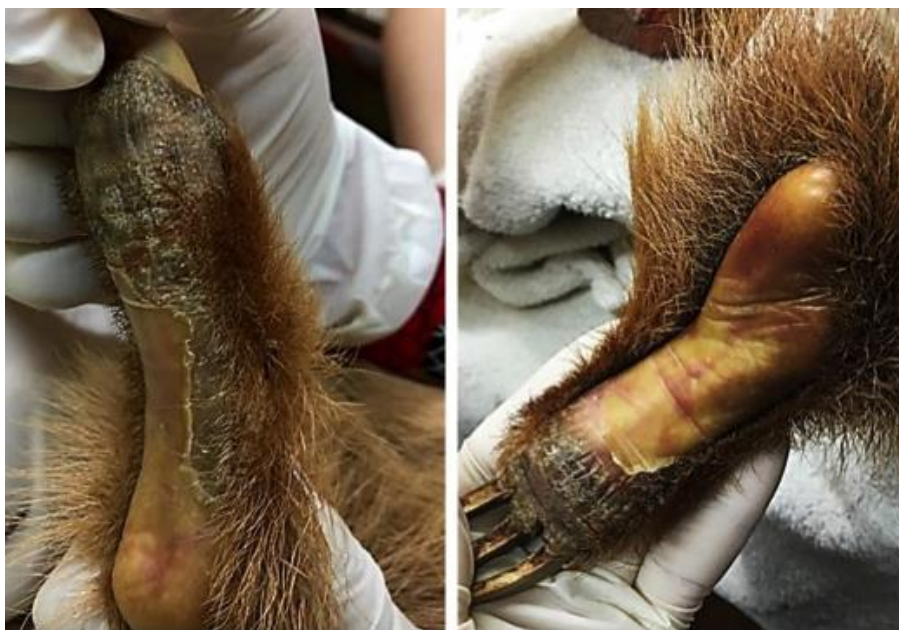


Figure 2. Lesions caused by dermatophyte infection. Note the multifocal scaling, erythema, and onychodystrophy of the digits. Photographs by author.

Blue color change on the RSM plates (Figure 3A, left half) and red color change on the DTM plates (Figure 3A, right half) indicated dermatophytosis. Colony top view appearance was cinnamon/mauve in color and reverse colony coloration was darkly

pigmented. Microscopic examination of conidia revealed ovoid-shaped macroconidia with three to six cells, which confirmed *Microsporium gypseum* dermatophytosis (Figure 3B). Skin impressions for secondary bacterial infection of the skin and skin scrapings for superficial and deep mites were negative for all three exhibition cases.

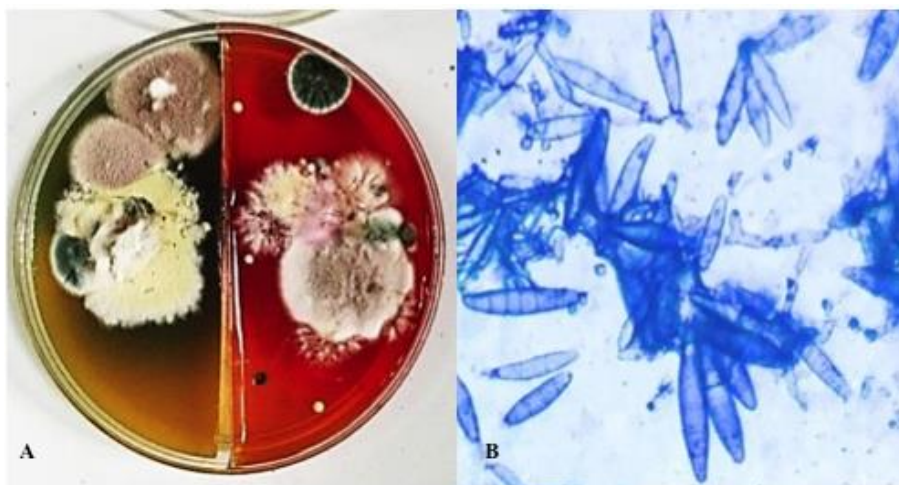


Figure 3. Dermatophytosis in three captive *C. hoffmanni* individuals. **A**, Top view of fungal contaminant growing on DTM fungal culture agar at day 10 of incubation. **B**, Microscopic examination of dermatophyte *Microsporium gypseum* macroconidia under 400x total magnification. Note the macroconidia ovoid shape with six or fewer cell divisions. Photographs by author.

Captive Non-Exhibition Adults

Two *B. variegatus* and one *C. hoffmanni* were evaluated for skin illness. A three-year-old male *C. hoffmanni* presented for ectoparasite removal. An engorged non-pathogenic tick was found on the ventral aspect of the individual's neck near the trachea (Figure 4A) and a 2 x 2 cm lesion was observed at the attachment site post removal



Figure 4. Secondary bacterial infection. **A**, Tick attachment site on ventral neck of *C. Hoffmanni*. **B**, Residual wound from tick attachment. **C**, Non-pathogenic tick. Photographs by author.

(Figure 4B). Microscopic interpretation of skin impression taken of tick attachment site on the individual's neck wound was consistent for pyotraumatic dermatitis due to high levels (3+) of cocci bacteria (C. Tamamoto, NCSU College of Veterinary Medicine-Dermatology Telephone Consultation, personal communication Oct. 27, 2016).

Skin impression, skin scraping, and fungal culture results were negative for a two-and-a-half-year-old female *B. variegatus* and a one-and-a-half-year-old male *B. variegatus* that both presented with flaky skin. Causation for the skin conditions in these two cases was inconclusive.

Free-Living Population

Five sloths from the wild presented with severe dermal lesions. Fungal cultures and skin scrapings from all five individuals were negative for mite infection and dermatophytosis. Pyotraumatic dermatitis was diagnosed in three of the five cases from the wild that presented with skin lesions. In the first case, a female *B. variegatus* was found with nails that were abnormally dark, hair thinning on the left forearm, and skin on the carpus that was easily removed and moist. The second and third cases were *C. hoffmanni* individuals that presented with burns on forearms that extended to the abdomen. Skin impression results from the three individuals were positive for cocci (3+) bacterial infection.



Figure 5. Yeast dermatitis. **A**, Ventral neck second-degree burn from electric shock trauma on an adult *C. hoffmanni* sloth found in the wild. **B**, Microscopic image of *Malassezia* yeast organism overgrowth under 1000x total magnification from acetate tape preparation. Photographs by author.

A single *C. hoffmanni* adult male presented with multiple areas of hair loss and second-degree burns after accidental electric shock trauma from telephone wires (Figure 5A). Skin impression revealed more than 10 *Malassezia* organisms per field of view (Figure 5B). The combination of clinical signs and high levels of organisms present on skin impression confirmed yeast dermatitis in this case (C. Tamamoto, NCSU College of Veterinary Medicine-Dermatology Telephone Consultation, personal communication Oct. 27, 2016).

Atypical Findings

Fungal culture results for the captive non-exhibition sloths had red color change on the RSM side (Figure 6A). Microscopic examination of the fungal contaminant revealed the presence of conidiophores that resembled paintbrushes, with conidia emanating from the top and conidiospores in finger-like chains on phialides projecting from vesicles (Figure 6B), which confirmed the presence of saprophyte *Penicillium* spp.

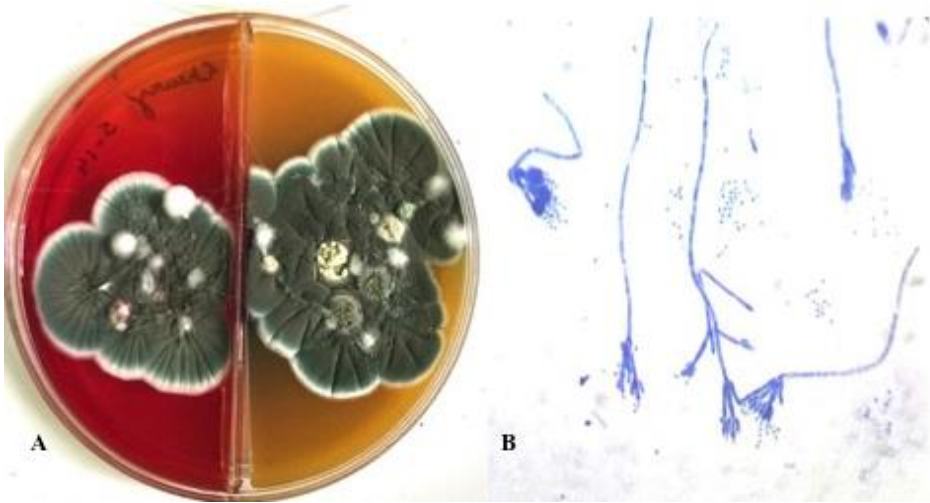


Figure 6. Saprophytic fungi growth. **A**, Red color change on RSM plate with absence of blue color change on DTM plate. **B**, Microscopic examination of fungal contaminant. Note the conidiophores that resemble paintbrushes with conidia emanating from the top. Photographs by author.

One adult *C. hoffmanni* female from the wild presented with extremely flaky skin and no apparent lesions or ectoparasites. On the 10th day of incubation, the fungal culture had both blue and red color change. From the top view, multiple fungal colonies appeared buff/powdery with reverse dark brown colony coloration on both RSM and DTM segments. Microscopic examination of fungal contaminant revealed curled hyphae consistent with *Trichophyton mentagrophytes*, but results were inconclusive due to the absence of macroconidia.

Discussion

The purpose of this study was to differentiate among skin diseases of Costa Rican sloth populations by utilizing the dermatologic diagnostic minimum database. Disease frequencies were then compared in order to establish which was the most prevalent. Due to pseudo-replications in the sampling procedure, chi-square analysis was not conducted on the data in this experiment; therefore, there is no significant statistical evidence to suggest that zoonotic ectoparasites are the primary cause of dermatitis in Coast Rican sloth populations. Nevertheless, the general trends of the trial indicate that the highest frequency of dermatitis was induced by zoonotic ectoparasites (37.5%).

The presence of *S. scabiei* mites on the sloths in this study confirmed the previous report by Sibaja-Morales et al. (2009), which recorded the first case of this parasite affecting both *C. hoffmanni* and *B. variegatus* individuals in Costa Rica. It is noteworthy that during this study two of the volunteer staff at the wildlife sanctuary developed pruritic rashes that resolved without any medical therapy. These rashes can possibly be attributed to zoonosis caused by the animal species *S. scabiei*, as human infestation is generally self-limiting.

Additional evidence of zoonotic disease was found in the exhibition population of *C. hoffmanni* individuals. The clinical presentations of the dermatophyte lesions and the microbiological findings observed in the present study are supported by previous reports from Xavier et al. (2008), which described dermatophytes in free-living *B. variegatus* individuals of Brazil. This is the first study to document dermatophytosis caused by the keratinophilic fungi *Microsporum gypseum* in captive Costa Rican *C. hoffmanni* populations. All of the sloths that presented with zoonotic ectoparasite infection were residents at the wildlife sanctuary.

Although it is not possible to confirm the origin of the infections at the wildlife sanctuary, several husbandry factors might have contributed to the increased rate of zoonotic parasitism observed in its populations. The nursery not only functioned as housing for infant sloths but also as a living space for volunteer staff and quarantined animals. Though quarantined animals were separated to prevent direct contact with the nursery sloth population, the personnel involved in the care of the nursery wildlife were a possible source for transmission of parasites, as they come in direct prolonged contact with both the quarantined individuals and the nursery sloths throughout the day. In addition, inspection of the exhibition cage revealed a suspended kennel containing stagnant water and numerous piles of moldy excrement on the cage floor. Sloths must travel to the ground to urinate and defecate, making them more at risk of fungal contraction, since *M. gypseum* is considered to be a geophilic dermatophyte found in the soil. However, transmission from direct contact with fur and dandruff that contain fungal particles must also be considered.

Secondary pyotraumatic dermatitis (18.8%) and *Malassezia dermatitis* (6.3%) from electric shock traumas were the most common skin ailments of sloths that presented from the wild. The four cases with shock wounds were found on the ground after heavy storms. Manuel Antonio experiences increased rates of rainfall from May to November; therefore, the frequency of shock traumas should be statistically analyzed in future studies to correlate seasonal variations with disease patterns. Common wounds of sloths in captivity, such as wire-induced injuries and fight wounds reported by Diniz and Oliviera (1999), were not observed in this study. Adequate enclosure size for the sloth populations at TSI and the exhibition population at the wildlife sanctuary enabled each sloth to establish its own territory; therefore, the risk for aggression between individuals was decreased.

Eleven fungal cultures in this study were positive for the saprophytic fungi *Penicillium* spp. Saprophytes live primarily on decaying vegetation and are commonly observed in human and animal clinical practices. Though the presence of the fungus does not generally indicate disease, penicilliosis can be pathogenic and fatal in immunocompromised individuals (Mok et al. 1997). As previously reported by Sibaja-Morales et al. (2009), sloths are at a higher risk of contracting disease due to the stress

factors associated with captivity. Immunosuppression from stress and constant exposure to materials harboring the *Penicillium* spp. fungus in sloth enclosures puts captive sloth individuals in danger of contracting nephrotoxic and carcinogenic mycotoxins produced by *Penicillium* spp. During this study, two *B. variegatus* individuals that were not evaluated for skin disease presented with sudden onset of upper respiratory distress. Pneumonia was confirmed in both cases at necropsy. This is important to note, as *Penicillium* spp. has been isolated from patients with pneumonia and respiratory disorders are the second most common organic disorder of sloths in captivity, as reported by Diniz and Oliviera (1999). Future studies investigating the pathogenicity of *Penicillium* spp. in captive sloths should be conducted to aid wildlife rehabilitators in maintaining the upper respiratory health of the species.

Conclusion

Increased biological security must be considered in order to eliminate further transmission of zoonotic diseases to wildlife staff, the general public, and other captive species. The wildlife sanctuary should establish preventive measures, such as volunteer dormitories and a separate isolation ward for quarantined animals. Cage-specific clothing, such as coveralls and disposable shoe covers, should be worn by staff at the wildlife sanctuary and at TSI whenever they are handling wildlife and entering enclosures, in order to avoid cross-contamination in their wildlife populations. The practice of responsible ecotourism by persons traveling to Costa Rica is also essential for the success of both species in captivity and in the wild. Practices such as touching, holding, and taking photographs that physically disrupt the sloth should be eliminated as this contributes to increased stress levels, disruption of the symbiotic algal communities on the sloth fur, and risk of zoonosis.

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A Comparative Analysis for the Identification of Gunshot Residues in Burnt, Decomposed Tissue and Cremated Bone Samples

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Abstract

Forensic anthropologists, pathologists, and analysts face challenges when undertaking the identification of gunshot wounds, particularly in burnt, decomposed tissue and burned bone samples. Gunshot wounds and marks can be unrecognizable in decomposed or charred remains, posing a challenge for forensic analysts doing qualitative examinations. Burning of human remains increases the difficulty of examining samples due to alterations made by fire or other sources of intense heating or burning.¹ It is also difficult to determine the precise entry of the projectile in burnt remains. Severe alterations of tissues can make a wound macroscopically unrecognizable or create surfaces that look like but are not gunshot wounds.¹ In such cases, quantitative instrumental methods such as inductively coupled plasma-mass spectroscopy and inductively coupled plasma-optical emission spectroscopy are ideal and definitive methods of inorganic analysis for trace metals in gunshot residues (GSR) in charred and decomposed remains. In studies to differentiate between two different bullet types (jacketed and non-jacketed) on absorbed tissue samples, quantitative analysis detects specific inorganic metal residues left by gunshot wounds—such as antimony, barium, lead, copper, and iron—in burnt/cremated bone and decomposed tissue samples. The quantitative instrumental methods tested here enable forensic researchers to detect GSR despite excess heat, charring, and decomposition processes in harsh environments, validating an important tool for detection of inorganic residues after degradation, by burning or decomposition, of evidence of gun-related violence and crimes.

Introduction

Gun-related violence and crime rates have risen steadily in the United States, and precise identification and analysis of gunshot residues (GSR) are needed to bring criminals to justice. Many gun-related crimes result in either the death of individuals or their compromise by severe internal injuries. General identification of GSR is determined using a gross injury examination, a qualitative analysis, at an autopsy. The interpretation of gunshot wounds can be difficult even when the deceased individual is well preserved, because the characteristics of gunshot wounds vary greatly based on the type of firearm

and ammunition used, the range of fire, and the location of the wound on the body.¹ Postmortem factors such as decomposition, burial, and insect activity make the identification of gunshot wounds even more challenging. Usually, forensic medical examiners and pathologists cut tissue sections where GSR is located and perform histological procedures to determine the presence of gunshot residues; however, microscopic examination may be useless if tissue and bone samples are burned, cremated, or decomposed. Hence, the ability to chemically detect and identify GSR around a suspected gunshot wound is desirable. Therefore, a precise method of identification is required for quantitative analysis in decomposed tissue samples. Inductively coupled plasma-mass spectroscopy (ICP-MS) can be utilized to identify and quantify GSR from two different bullet types, jacketed and unjacketed.

Forensic anthropologists face similar challenges when undertaking the identification of gunshot wounds in tissue and bone samples subjected to fire. Burning or carbonization of human tissue makes it difficult for forensic anthropologists to identify the specific lesions made by the projectile(s) in bone. Severe alterations of the tissues can make a wound macroscopically unrecognizable or create surfaces that resemble gunshot wounds but are not.¹ A chemical or instrumental analysis not only can help forensic anthropologists and pathologists, but will precisely discern the composition and quantity of GSR fragments in areas where entrance wounds are expected to be located. Thus, a chemical analysis will improve the analysis and yield optimum results for GSR, in contrast to a qualitative examination of the remains in which error may readily occur.

Various techniques exist for quantifying and identifying metal and primer composition in GSR. However, a quantitative chemical analysis of GSR has rarely been conducted on burnt bone and tissue samples. A precise identification and quantification of GSR and components in degraded tissue can be definitively determined utilizing inductively coupled plasma–optical emission spectroscopy (ICP-OES) or inductively coupled plasma–mass spectroscopy (ICP-MS). Two studies were performed to quantify heavy metal residues in GSR in decomposed tissue and in burnt tissue. ICP-MS and ICP-OES were the instrumental methods used to analyze trace inorganic metals in these tissue samples.

Composition of GSR

GSR, which may also be known as cartridge discharge residue, is comprised of particles produced during the discharge of a firearm.² When a cartridge round is fired from a firearm, combustion products from the primer and the propellant are released simultaneously at great speeds. GSR is composed of unburned and partially burnt propellant powder, particles from the ammunition primer, smoke, grease, lubricants, and metals from the cartridge as well as from the weapon itself.³ Organic compounds originate from propellant and firearm lubricants, taking the form of partially burned gunpowder particles. Inorganic residues consist of inorganic metals such as lead (Pb), barium (Ba), and antimony (Sb), and represent the primer material at the base of the bullet. These combustion materials from the primer, propellant, and other sources escape from weapon openings and vaporized materials that solidify into particulates.² Less common inorganic elements in bullets include aluminum (Al), sulfur (S), tin (Sn), calcium (Ca), potassium (K), chlorine (Cl), copper (Cu), strontium (Sr), zinc (Zn), titanium (Ti),

and silicon (Si). These metals may be incorporated in bullet casings, bullet core, and possibly other sources of primers like mercury fulminate.⁵ Organic GSR primarily comes from materials derived from the propellant powder and includes compounds classified either as low explosives or additives based on their chemical composition. Low explosive material may consist of nitrates, nitrites, nitroglycerin, potassium chlorate, smokeless powder, black powder, and many other compounds required to undergo ignition by the primer to achieve the outward expansion of the bullet. The organic and inorganic material can be fit into a small cylindrical cartridge as shown in Figure 1.

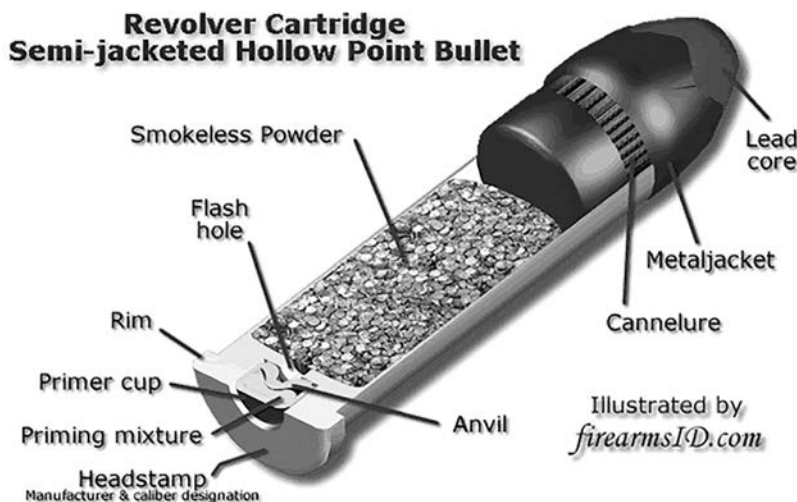


Figure 1. Revolver cartridge, semi-jacketed hollow point bullet.⁴

The cartridge case, bullet, bullet coating, and metal jacket shown in Figure 1 contain specific elements that can be detected via instrumental analysis. Virtually all cartridge cases are made of brass (70% copper, 30% zinc). A few cartridge cases have a nickel coating. Primer cases are of similar composition to that of cartridge casings; they are made of brass (Cu, Zn). Bullet cores are most often lead (Pb) and antimony (Sb), with a very few bullet cores having a ferrous alloy component to it. Bullet jackets are usually brass (90% copper with 10% zinc), but some are a ferrous alloy and some are aluminum.⁴ Some bullet coatings may also contain nickel, since bullet production is inexpensive despite environmental hazards. Understanding the components of bullet cartridges and GSR, forensic scientists can perform various instrumental analyses for the precise quantitative detection of heavy metal inorganic- and organic-based explosive residues found in gunpowder.

ICP-MS Analysis of Decomposing Tissue Samples

Replicating a previously reported study by Udey, Hunter, and Waddell Smith,⁵ a study was performed on three euthanized pigs to generate the quantitated data in Tables 2 and 3. Two dead pigs were shot 12 times each using a Smith & Wesson .357 Magnum

revolver.⁵The first pig carcass was shot with a 158 grain copper-jacketed hollow point ammunition with a jacketed bullet base. The second was shot with the 158 grain non-jacketed lead ammunition.⁵The supplier for both ammunitions was the Remington Arms Co. Inc. The gun barrel was cleaned after each shot, and the chamber was cleaned before reloading to prevent possible cross-contamination that could arise from this analysis. All three pig carcasses were then transported to the research field, where the control pig was stabbed 12 times to create open wounds to attract insect activity similar to the shot pigs. The pig carcasses were placed inside separate wire cages to protect them from predators while still allowing exposure to the environment.⁵ The wounds and histological samples were collected over a period of 49 days. One tissue section was removed from each tissue sample from the two gunshot pigs and the control carcass, and was then run through microwave digestion and ICP-MS to quantitate and analyze the elements of interest.

The researchers compared the decomposed tissue and a fresh tissue sample. It is expected that a decrease in concentration for various GSRs will occur via decomposition. The five elements of interest in this study are: Iron (Fe), Copper (Cu), Antimony (Sb), Barium (Ba), and Lead (Pb). They were quantitated using ICP-MS method, and the limits of quantitation were calculated and reported for each metal species. The limit of quantification (LOQ) in Table 1 describes the smallest concentration of an analyte that can be reliably measured by an analytical procedure or instrumental method, in this case ICP-MS. All elemental signals were monitored in both the undiluted and diluted tissue sample sets. Iron (Fe) and copper (Cu) are present in relatively low levels throughout the study. These elements were quantitated using the undiluted digest samples so that signals remained within the linear range of the calibration curve. The elements antimony (Sb), barium (Ba) and lead (Pb) were more concentrated and quantitated in the diluted samples to ensure that sample signals were within the linear calibration curve range and did not saturate the detector.⁵For all elements under analysis, errors were less than ten percent (<10%), as shown in Tables 1 and 2, indicating that the instrument was accurately quantitating the elements in all samples and that the instrumental technique was a highly sensitive method for analyte detection.

Table 1. Limit of quantification (LOQ) values for fresh and decomposed tissue samples.⁵

Element	LOQ (µg/L)	
	Fresh Tissue Study	Decomposition Study
⁵⁶ Fe	5	5
⁶³ Cu	5	5
⁶⁶ Zn	10	10
¹²¹ Sb	<0.1	<0.1
¹³⁸ Ba	0.5	<0.1
²⁰⁸ Pb	0.25	0.25

Table 2. Average reference material recovery values for fresh and decomposed tissue samples.⁵

Element	Average % Error	
	Fresh Tissue Study	Decomposition Study
⁵⁶ Fe	7	0.5
⁶³ Cu	1	6
¹²¹ Sb	2	4
¹³⁸ Ba	6	7
²⁰⁸ Pb	3	5

The analyte concentrations are calculated throughout the decomposition stages from Day 0 to Day 49; the range of mean concentrations for each element of interest is shown in Table 3. The concentrations encompass a certain degree of variability as the highest element concentrations did not necessarily occur on day 1 of the decomposition process and the lowest concentrations did not necessarily occur on day 49.⁵ The analyte concentrations in the decomposed tissue samples did not produce slight or observable changes as one would expect throughout the decomposition process. The mean element concentrations were calculated and recorded for six tissue samples from each bullet type and collected throughout the study at different stages of decomposition on days 0, 5, 14, 24, 34, and 44 in the process.⁵

Table 3: Mean element concentration ranges in decomposition process. ⁵

Element	Range in Element Concentration (µg/g) Through Moderate Decomposition		
	Control	Jacketed	Nonjacketed
⁵⁶ Fe	83–235	348–720	242–438
⁶³ Cu	12–27	306–835	99–166
¹²¹ Sb	10–15	197–3677	1722–3923
¹³⁸ Ba	ND*	1721–18159	5057–16599
²⁰⁸ Pb	0–11	702–11010	42753–131245

*ND indicates “not detected.”

As shown in Figure 2, the analytes of interest in this study show higher concentrations in tissue with gunshot wounds relative to the control tissue and procedural blank samples, indicating that this a sensitive method. Mean element concentrations for copper and barium at the 99% confidence level and for iron and lead at the 95% confidence level were significantly higher in tissues shot with full-jacketed

ammunition compared with the control. For tissue samples shot with non-jacketed ammunition, all elements were present at significantly higher concentrations in the shot tissue compared with the control tissue at the 99% confidence level.⁵ All elements in this study are suitable for differentiating tissues with gunshot wounds from control tissues throughout moderate decomposition processes.

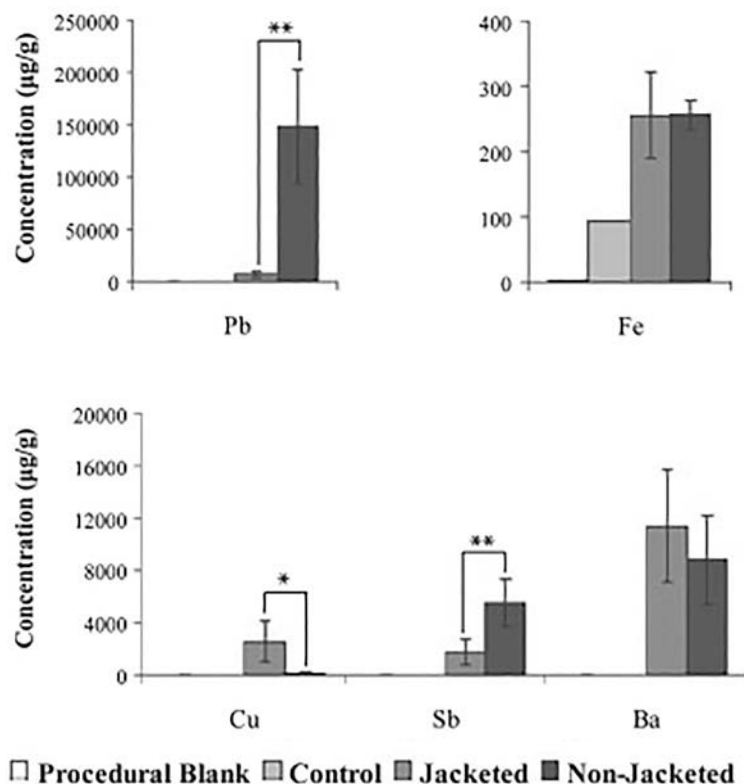


Figure 2: Mean concentrations for different element/analyte species under study via ICP-MS.⁵

The variation in elemental concentrations between tissue samples from carcasses shot with jacketed and those shot with non-jacketed bullet types provides evidence of the bullet make and composition, and differentiates the two bullet types. Higher concentration levels of lead (Pb) are detected in non-jacketed bullet ammunition while copper (Cu) is detected at higher concentrations in jacketed bullet ammunition.

The results of this decomposition study for the comparison of two bullet types (jacketed and non-jacketed) in decomposed tissue samples suggest that these specific metal species can still be detected via ICP-MS when conditions do not favor qualitative analyses. Despite the tissues' having undergone a 49-day period of decomposition, the five metal species were still detected with a highly sensitive instrument coupled method (ICP-MS). It was thought that certain metal species would dissipate in the environment

throughout the 49-day decomposition period due to temperature and weather effects. Other factors such as insect activity, decomposers, and soil acidity could very well affect the detection of these analytes. This study provided strong supporting evidence that elemental inorganic residues in GSR can still be detected and quantitated after decomposition processes. It is evident from this study that trace amounts of heavy metal GSR components can still be detected even when a murderer dumps or disposes of the body for decomposition.

ICP-OES Analysis of Cremated Bone and Burnt Tissue Samples

As published in 2013, forensic researchers at the University of Milan analyzed GSR in cremated bone and bone fragments from both full-metal-jacketed projectiles and non-jacketed projectiles,¹ and the present study replicated their inquiry. The morphological features of a gunshot wound on bone depend on many variables; these include firing distance, type of ammunition, type of firearm, and location of the gunshot wound on the body.¹ The typical morphology of a gunshot wound, however, can vary greatly when it undergoes severe alterations by charring or cremation. These types of alterations make it extremely difficult for forensic anthropologists and forensic pathologists to examine the morphological striations and markings caused by projectile firing on bone. A chemical analysis is the only viable and definitive option for trace analysis of GSR components, particularly for residues of heavy metals commonly found in bullets. Little research has been performed on burnt and cremated bone samples. This quantitative analysis involves inductively coupled plasma-optical emission spectrometry (ICP-OES), which works in conjunction with a qualitative analysis or approach for comparison using a scanning electron microscope coupled with a dispersive x-ray analyzer (SEM-EDX). Although the SEM-EDX method of analysis does allow for identification and detection of metal residues, quantification is deemed a subjective analysis. It was decided to perform this study with ICP-OES to verify whether this method yielded positive results on burnt bone, allowing for a more objective quantification of the chemical residues in GSRs.¹

This study evaluated the usefulness and reliability of the ICP-OES instrumental analysis on burned samples. This method was used to quantify trace amounts of GSR on charred tissue and bone samples. The study involved sixteen adult bovine ribs, eight of which contained soft tissues, while the other eight ribs were completely skeletonized. These samples were shot using two kinds of projectile, a 9-millimeter full metal-jacketed projectile and an unjacketed projectile. The analysis allows for the identification of GSR from both bullet types in charred tissue and bone fragments. Each rib was shot at a firing ground, with a Beretta-type 98 FS (series 92) caliber 9 mm. Two kinds of projectile were used: the Magtech-cbc LRN projectiles (with unjacketed lead bullets) and the Fiocchi 123 projectiles (with full metal-jacketed bullets).¹ The gunshot wound after discharge displayed clear visible circular lesions in all samples, along with several radiating fractures on the bone. The samples then underwent a charring cycle to simulate the carbonization of human bodies. The charring cycle exposed the bone and tissue samples to very high temperatures in an electric oven at 800°C for 12 hours; this was followed by a 12-hour cooling cycle.¹ As expected, every sample exhibited the morphological features of calcined bone with complete loss of soft tissues. The oven used was an electric industrial

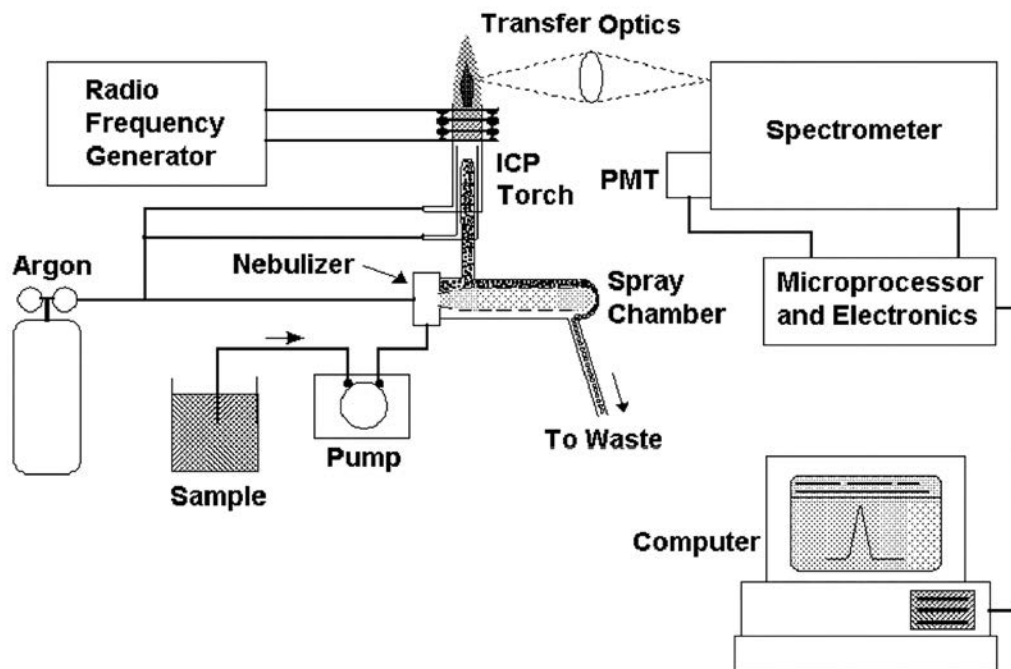


Figure 3: ICP-OES schematic and flowchart.⁶

machine (model Vega 150) with a capacity of 150 L (max temp. of 1280°C, with a rating of 10.0 kW and a tension of 230–400 V).¹ The heating cycle was performed on eight of the sixteen ribs.

After the charring cycle, the samples were taken out for sampling with a cotton swab soaked in 2mL of 30% nitric acid, sonicated in an ultrasonic bath for 10 minutes, and left at rest overnight. The sample was diluted in 5mL of DI water in which the cotton swab was rinsed to recover any leftover residues of the sample.¹ The ICP analysis was then performed using three calibration standards of 0.5 ppm, 2 ppm, and 5 ppm. The analysis was repeated three times for each sample. Overall, for each category composed of four ribs, two ribs were analyzed before and two ribs after the carbonization cycle. Two gunshot ribs were used as control samples, and all ribs underwent quantitative analysis via ICP-OES before and after the charring cycle. The metals analyzed under ICP-OES instrumental analysis that are under investigation for gunshot residue in charred bone and tissue samples are lead (Pb), antimony (Sb), barium (Ba), zinc (Zn), and copper (Cu).

The flowchart for the ICP-OES instrument in Figure 3 illustrates how the instrument analyzes inorganic atoms via spectroscopic analysis. In inductively coupled plasma-optical emission spectroscopy (ICP-OES), the sample is usually transported into the instrument as a stream of liquid sample. Inside the instrument, the liquid is converted into an aerosol through a process known as nebulization, with argon (Ar) gas as the carrier gas.

Pneumatic nebulizers make use of high-speed gas flows to create an aerosol.⁶ The sample aerosol is then transported to the plasma where it is ionized, atomized, and excited by the plasma.⁶ The plasma's maximum temperature is 10 000 Kelvin, which can excite atoms to higher electronic states and yield a very sensitive process. The excited atoms and ions emit their characteristic wavelengths, which are collected by a spectrometer device that sorts the emitted radiation into their individual spectra. A spectrum is an electromagnetic spectrum that is characteristic of individual atoms and elements based on their electronic configurations. A spectrum is, in effect, the fingerprint of the atom or element. The radiation is detected and turned into electronic signals that are converted into concentration information in computer software.⁶

All samples, both fresh and charred, resulted in significant concentrations of metallic residues compared with the control samples. The results of this GSR study indicated that the charring process did not significantly alter the values reported.¹ The ICP-OES analysis, via swabbing the wound site in the bullet entrance site, confirms that metallic residues from gunshot wounds can survive at very high temperatures (~800°C). The amount of surviving GSR after the carbonization process is always smaller, but in sufficient trace quantities to be detected with ICP-OES analysis.¹ Moreover, the study confirmed lead (Pb) as the main constituent of GSR, with significantly greater concentrations in samples shot with theunjacketed bullets. In the latter samples, a larger amount of residues was globally detected in both fresh and charred samples, probably due to the absence of the jacket, which allows the residues to spread and stick to the bone samples.

Table 4 lists the analyte concentrations for five elements/metals identified in GSR from both the full metal jacketed bullet projectile and theunjacketed lead bullet projectile. In Table 4 the results from the two types of ribs and two types of projectiles are organized into groups, each composed of four samples: from number 1 to 4, naked ribs and full metal-jacketed bullet (NF); from number 5 to 8, naked ribs and lead unjacketed bullet (NL); from number 9 to 12, dressed ribs and full metal-jacketed bullet (DF); and from number 13 to 16, dressed ribs and lead unjacketed bullet (DL).¹ The data in Table 4 display a decrease in metal concentration in charred bone samples compared to fresh tissue samples. Possible explanations for this may be the heat-induced volatilization in the electric oven to simulate the charring process that would occur in a real life situation, such as if a murderer sets the evidence on fire for the purpose of getting rid of it.

Table 5 provides a list of inorganic compounds that may contribute to GSR analysis via ICP-OES or ICP-MS. The compounds listed in Table 5 can be targeted to detect trace amounts of inorganic compounds that are characteristic of the bullet makeup. There are a large variety of mixtures for primers and casings. However, similar elements detected in previous studies using ICP-MS and ICP-OES comprise virtually all GSR components found in manufactured bullets and their fragments.

The results of this GSR analysis on cremated and burnt bone samples were quantified and shown to be very sensitive, as well as a reliable means of detection in burnt samples and degraded material. This instrumental method is optimum for analysis and detection of GSR trace metals on cremated bone and charred bone fragments. All samples, both fresh and charred, resulted in significant concentrations of metallic

Table 4: Concentration of absorbed metals from GSR on tissue samples for fresh and charred samples.¹

Samples	Metals (Concentrations in $\mu\text{g}/\text{cm}^2$)						
	Pb	Sb	Ba	Zn	Cu		
NF Fresh	1	50	1.5	4.5	3.5	4.0	
	2	36.3	0.8	8.6	2.2	2.2	
	Mean	43.25	1.15	6.55	2.85	3.1	
	Charred	3	3.28	0.145	1.78	2.31	2.41
		4	7.7	0.4	3.8	2.2	2.2
		Mean	5.49	0.273	2.79	2.255	2.305
NL Fresh	5	1565	211	4.3	2.0	2.1	
	6	1602	230	5.8	1.2	1.5	
	Mean	1583.5	220.5	10.1	1.6	1.75	
	Charred	7	540	12	11	1.5	0.9
		8	798	36	4.7	1.1	0.7
		Mean	669	24	7.85	1.3	0.8
DF Fresh	9	19.5	3.5	25.0	3.0	4.5	
	10	25.2	2.3	9.1	5.5	4.7	
	Mean	22.35	2.9	17.05	4.25	4.6	
	Charred	11	2.3	0.2	1.3	3.5	0.35
		12	4.8	0.7	2.9	3.9	2.1
		Mean	3.55	0.45	2.1	3.7	1.225
DL Fresh	13	780	102	52.5	1.8	1.5	
	14	478	225	4.2	2	0.1	
	Mean	629	163.5	28.35	1.9	0.8	
	Charred	15	995	12.3	34.2	0.8	0.8
		16	442	76	7.1	0.9	0.5
		Mean	718.5	44.15	20.65	0.85	0.65
Negative control*	0.1	0.45	0.5	0.45	0.05		
Negative control†	0.2	0.11	0.23	0.97	0.02		

NF, "naked" ribs, full metal-jacketed bullet.

*Before the charring cycle.

†After the charring cycle.

residues compared to the control samples. The results indicate that the charring process did not yield significant alterations in the values reported.¹ This study provides strong supporting evidence that the ICP-OES method of analysis, via swabbing the wound site or the bullet entrance, confirms that metallic residues from gunshot wounds can survive

Table 5: Inorganic compounds encountered in GSR. ²

Compound	Source of Compound
Aluminum	Primer/case
Aluminum sulfide	Primer mix
Antimony	Case/bullet
Antimony sulfide	Primer mix
Antimony sulfite	Primer mix
Antimony trisulfide	Primer mix
Arsenic	Case
Barium nitrate	Primer mix/propellant powder
Barium peroxide	Primer mix
Bismuth	Case
Boron	Primer mix
Brass	Case
Bronze	Bullet
Calcium carbonate	Propellant powder
Calcium silicide	Primer mix
Chromium	Bullet
Copper	Bullet jacket/primer cup/case
Copper thiocyanate	Primer mix
Cupro-nickel	Bullet jacket
Gold	Primer mix
Ground glass	Primer mix
Iron	Rust inside barrel, bullet
Lead	Bullet
Lead azide	Primer mix
Lead dioxide	Primer mix
Lead nitrate	Primer mix
Lead peroxide	Primer mix
Lead stannate (stypnate)	Primer mix
Lead thiocyanate	Primer mix
Magnesium	Primer mix
Mercury	Primer mix
Mercury fulminate	Primer mix
Nickel	Case
Nitrate	Black powder
Phosphorus	Case
Potassium chlorate	Primer mix
Potassium nitrate	Propellant powder/primer mix
Prussian blue	Primer mix
Red brass	Bullet jacket
Silicon	Primer mix
Sodium nitrate	Primer mix
Sodium sulphate	Propellant powder
Steel	Bullet core/case
Strontium nitrate	Primer mix
Sulphur	Primer mix/black powder
Tin	Primer mix
Titanium	Primer mix/Lead free primer mix
Tungsten	Bullet
Yellow brass	Bullet jacket/case
Zinc	Primer cup
Zinc peroxide	Primer mix
Zirconium	Primer mix

at very high temperatures (~800°C).¹ The study yielded trace amounts of GSR metal particulates which can be detected if the perpetrator attempts to burn away the body or the evidence.

Conclusions

The detection and quantification of traces of metals encountered in GSR are superior to qualitative examination under certain conditions. Qualitative difficulties resulting from fire or accelerant sources, and decomposition reactions arising from the environment can be addressed by conducting a quantitative analysis. The incorporation of an instrumental analysis is important for quantifying and identifying GSR in conditions unsuitable for qualitative analysis. As shown by the data in Tables 1-4 and Figure 2, GSR components can persist at very high temperatures and throughout decomposition processes. All data were generated via analytical procedures to calculate concentration values linear with respect to their calibrations. Calibration curves were not included in this research, and a few statistical problems exist in both studies involving ICP-MS and ICP-OES. The statistical problems are somewhat minor and can be corrected in future research. Future research goals in these studies include method validation of both analytical instrumentations in this research, as well as spectrophotometric and IR spectroscopic analysis on organic GSR before and after burning and/or decomposition. Lastly, future research goals in identifying GSR components include linking to an exact bullet make and manufacturer in order to help law enforcement agencies determine possible suspects based on gun owner registry. These studies provide evidence for the detection of GSR in severe conditions such as in burnt bone and tissue, and decomposed tissue samples. The detection and quantification of trace metals in GSR require specific conditions. Nonetheless, the results of these studies can help law enforcement agencies determine cause of death.

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Pinga (Dance)

Dipali Tikone, Pooja Nikalje, Vrushali Thombare, Jyoti Ghule

Faculty sponsor: Dr. Evan Bridenstine

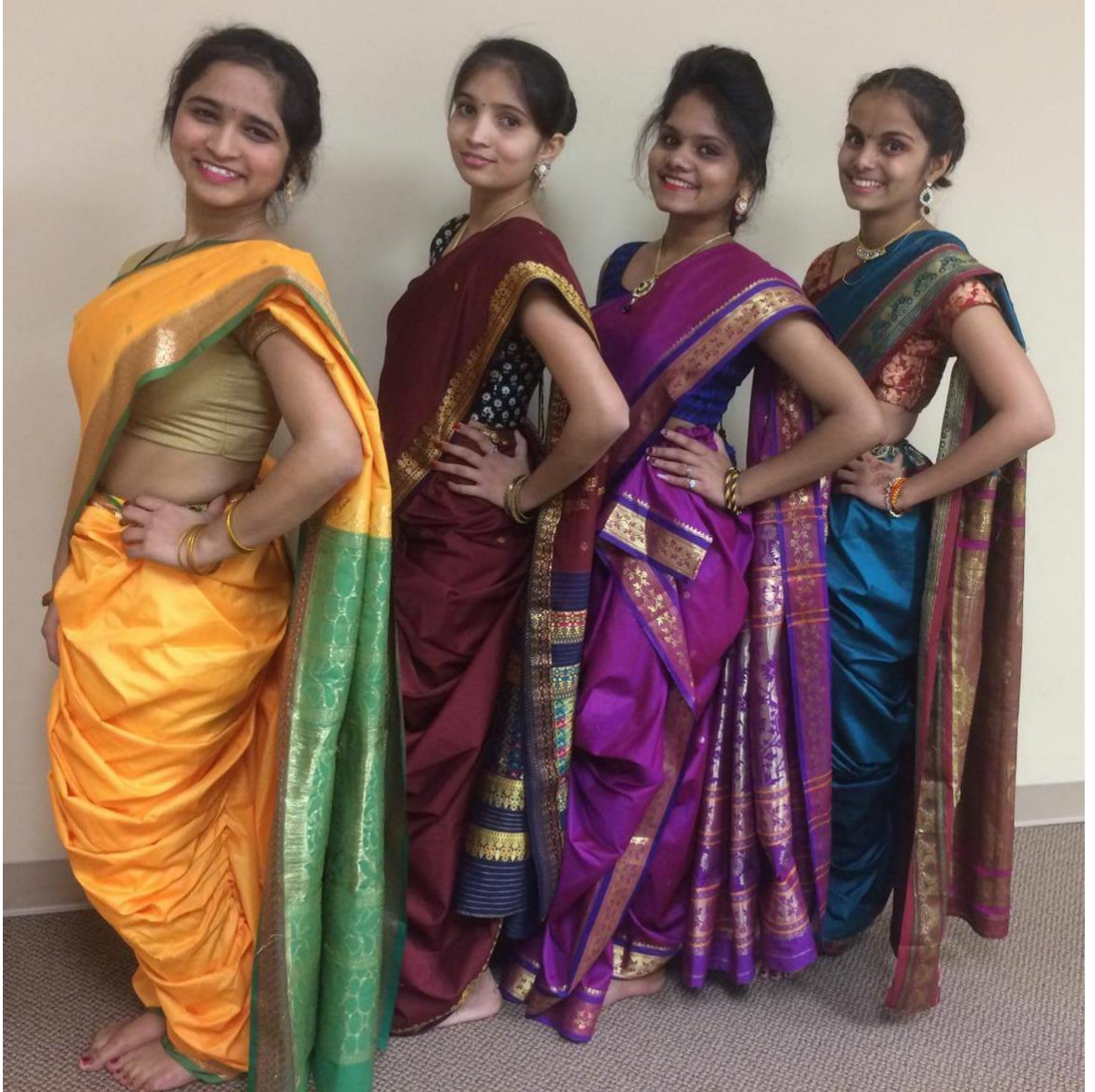
Department of Theatre

Statement from the Artists

India being a male dominated society, for centuries women did not have the freedom to leave their houses. Only at certain festivals could women gather with other women from their neighborhood, when they performed a number of dances to entertain themselves. Pinga was one of the dances performed during these gatherings. It is also said that the pinga dance form was traditionally only performed during the festival called Mangalagaur, a celebration of newlywed women common in the Indian state of Maharashtra. Nowadays, along with many other dance forms, women perform pinga on the stage on many occasions to entertain a general audience. The dance form has also been modernized a little, and choreographers interpret the steps in their own ways to make the dance simpler yet keep the authentic traditional qualities.

A video recording of the performance by Mss. Tikone, Nikalje, Thombare and Ghule is available through the online edition of the *Monarch Review*, volume four, at <http://www.methodist.edu/monarch-review-4> and at





Dancers Jyoti Ghule, Dipali Tikone, Pooja Nikalje and Vrushali Thombare

Flute Performance of Sergei Prokofiev's *Sonata in D Major, Opus 94,* Movement IV. Allegro con Brio

Katlin Harris

Faculty sponsor: Dr. Keith Dippre
Department of Music

Statement from the Artist

Prokofiev's Flute Sonata in D Major was written in the midst of World War II, during which the government of the Soviet Union relocated him, as it did several other artists, to be further away from the fighting that ravaged the western regions of the country. Overall, this composition is written in a more classical style that features rhythmic, harmonic, and timbral elements associated with Russian music. The fourth movement allows the performer to showcase technical ability as well as lyrical playing. The technical and lyrical qualities merge in rapid, impressive passages and soaring melodies that allow each listener a range of emotional responses.

A video recording of the performance by Ms. Harris is available through the online edition of the *Monarch Review*, volume four, at <http://www.methodist.edu/monarch-review-4> and at



Sergei Prokofiev's
Sonata in D Major, Movement IV—
Page 1 of Score

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Flauto
IV

Allegro con brio

18116

A Computational Study for Optimizing a Synthetic Pathway to a Difluorinated Gingerol Compound

Christopher West

Faculty Sponsor: Dr. Eun Hoo Kim

Department of Chemistry and Physical Science

Abstract

[6]-Gingerol is an abundant compound that is isolated from the roots of ginger and contains physiological and medicinal properties. [6]-Gingerol offers antiemetic, anti-inflammatory, antioxidant, and anticancer activity. However, in the body, [6]-gingerol is metabolized into [6]-shogaol during a rapid dehydration reaction by exposure to heat and acidic conditions in the body, specifically the gastrointestinal tract, and this reaction rapidly degrades the medicinal value of the natural compound. In contrast, a difluorinated gingerol compound would have, it is believed, greater stability and therefore greater therapeutic value. To optimize a synthetic pathway to produce the end product 2,2-difluorogingerol, *ab initio* molecular optimizations and calculations of vibrational frequencies and energy values were performed using the Gaussian 03 software. These calculations involve computational methods to compare differences in energies between the starting reactants vanillylacetone **1** and benzylacetone **3**, and reactant enolate intermediaries **2** and **4** (see Figure 3), as well as several other starting reactants. It is hypothesized that the presence of the methoxy (-OCH₃) and hydroxyl (-OH) aromatic groups contribute to the activation of the aromatic benzene ring in vanillylacetone **1**. This suggests that vanillylacetone **1** is stable in contrast to benzylacetone **3**. This research builds on a route, previously reported by this researcher, by which vanillylacetone **1** reacts with base lithium bis(trimethylsilyl)amide (LiHMDS) to deprotonate the α -proton and generate reactive enolate. In contrast, when benzylacetone **3** reacts with base LiHDMS to generate enolate intermediate **4**, the process is very reactive. The energy values between the starting materials and the reactive enolate intermediates (see Figure 3) suggest an optimal synthetic pathway for benzylacetone **3** but not vanillylacetone **1**.

Introduction

In the last few decades, herbal resources have been identified to possess various medicinal properties and physiological effects in the body. Ginger, a potent herb, is believed to have first been harvested by the Chinese and the Indians, and is widely known for its medicinal uses. Over the years, researchers isolated ginger into its bioactive components. Among the bioactive compounds discovered were [6]-gingerol ((5S)-5-

hydroxy-1-(4-hydroxy-3-methoxyphenyl) decan-3-one), which has been found to exhibit pharmacological and physiological effects in the body.¹ [6]-Gingerol (Figures 1 and 2) is the most abundant bioactive component from ginger and is isolated from its roots. It is a widely recognized antiemetic for the treatment of nausea, vomiting, and the adverse side effects of chemotherapy. It has anti-inflammatory, anti-tumor, and anesthetic activities. It can also be used to treat various anxiety disorders, cardiovascular diseases, and neurodegenerative disorders like Alzheimer`s and Parkinson`s.

There is only one problem with [6]-gingerol: it is very unstable. When it is metabolized, [6]-gingerol undergoes a dehydration reaction by exposure to high temperatures and highly acidic conditions in the gastrointestinal tract. [6]-Gingerol is metabolized into [6]-shogaol ((*E*)-1-(4-hydroxy-3-methoxyphenyl) dec-4-en-3-one) by a rapid dehydration reaction due to the presence of a β -keto hydroxyl group (shown in Figure 1).² A dehydration reaction is a type of β -elimination reaction in organic chemistry resulting in the loss of water.

The stability of [6]-gingerol and [6]-shogaol in aqueous solutions shows that [6]-gingerol degrades to form [6]-shogaol reversibly at 100 °C and 1.0 pH within 2 hours.² The β -keto hydroxyl group makes [6]-gingerol susceptible to a dehydration reaction resulting in the removal of the hydroxyl ($-OH$) group and a hydrogen ion (H^+) to form a double bond (Figure 1).

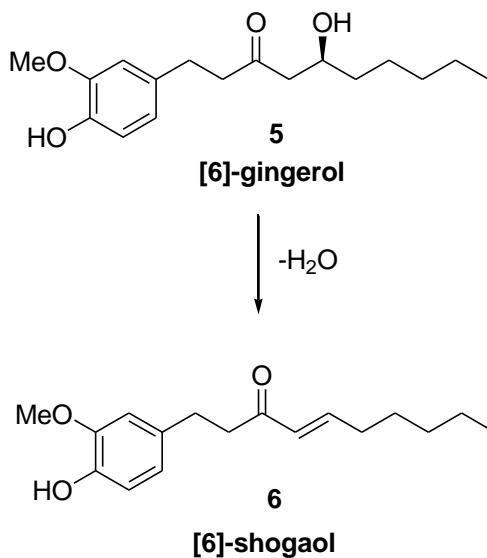


Figure 1. Dehydration from [6]-gingerol to [6]-shogaol.²

A difluorinated gingerol compound, it is thought, will possess greater thermal and chemical stability, and therefore greater medicinal value than [6]-gingerol. The computational methods employed in this study point to a synthetic pathway that minimizes the energies produced from steric and bulky interactions and provides an

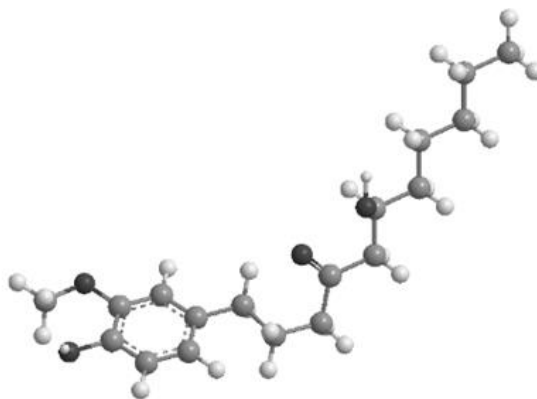


Figure 2. Three-dimensional representation of [6]-gingerol. (Structure produced from Chem3D Ultra 8.0)

energy-favorable process to produce an appropriate di-fluorinated compound: within the limits of this study, the starting reactant benzylacetone yielded efficient synthesis of difluorinated product while vanillylacetone was singularly inefficient. This research supports the claim that vanillylacetone **1** is too stable and nonreactive in contrast to benzylacetone **3**, the more reactive starting material (Figure 3). Vanillylacetone **1** did not deprotonate to yield intermediate **2** and [6]-2,2-difluorogingerol, the compound of medicinal interest.

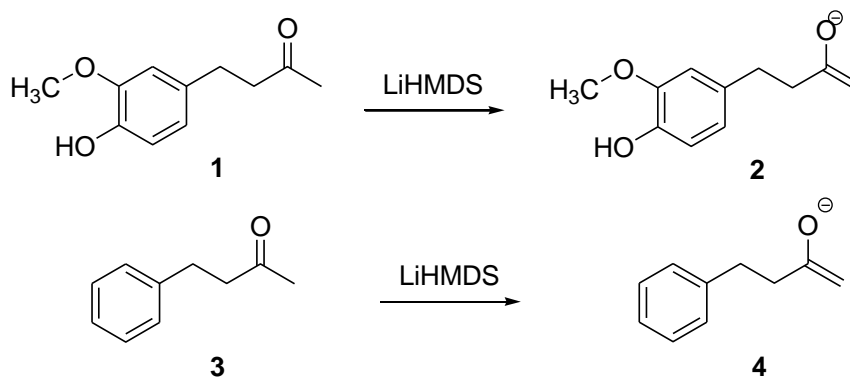


Figure 3. Formation of reactive enolates, where the starting reactants are vanillylacetone **1** and benzylacetone **3**. (Compounds produced from ChemDraw Ultra 8.0)

Hypothesis and Purpose of Research

The goal of the research is to ascertain an optimal pathway to incorporate two fluorine molecules to [6]-gingerol (Figures 1 and 2) in order to enhance thermal and chemical stability, and thus improve the therapeutic value of the modified gingerol compound.

A previous multi-step synthesis to achieve 2,2-difluorogingerol was attempted; however, the desired end product was not attained. The purpose of this computational research is to determine the causes and errors associated with previously reported synthetic routes. The hypothesis for this experiment is that, in the second step of the organic synthesis, the presence of the phenylhydroxy group (-OH group) and phenylmethoxy group (-OCH₃) in vanillylacetone **1** (Figure 3) is what accounts for the low percent yield of the desired difluorogingerol end product. It is suspected that the starting material vanillylacetone **1** is too stable and not very reactive.

To ascertain a superior method of synthesis, a computer-based molecular optimization is undertaken to calculate the B3LYP energy differences using the standard *ab initio* Hartree-Fock method to distinguish between different reactants, reaction intermediates, and specific molecular conformations. The same calculations are performed on benzylacetone **3** and intermediates **2** and **4** in Figure 3, as well as on compounds depicted in Figure 4. This study will also yield the enthalpic (ΔH), entropic (ΔS), and Gibbs free energy (ΔG) values, as well as the partial charge values, dipole moments, rotational and vibrational frequencies, and activation energies for various starting reactants.

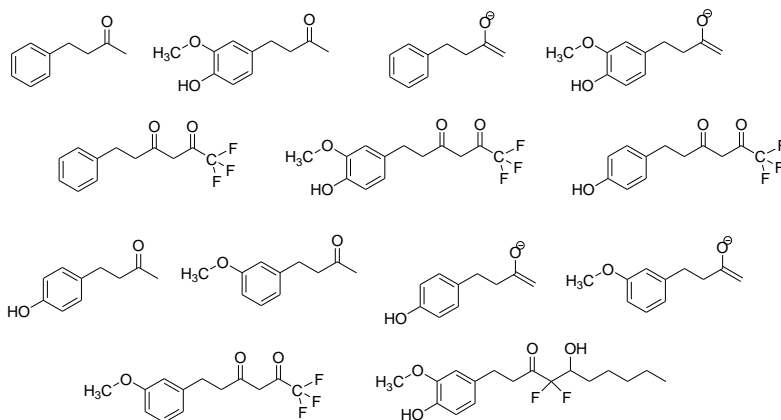


Figure 4. Library of compounds that undergo *ab initio* Hartree Fock calculations. (Structures produced from ChemDraw Ultra 8.0)

This study does not consider acidity of protons in the molecule, especially the phenolic hydrogen position ($pK_a \cong 10$). The paper is structured to help the reader understand the complex calculations associated with the research. The research does not involve biochemical analysis or compound-substrate binding studies, but instead encompasses computational and organic synthetic formulation only.

Methodology

This inquiry did not involve a synthesis of a difluorinated gingerol compound, but rather a computational study for different starting reactants and reactive intermediates as seen in in Figures 3 and 4. The materials used in this experiment were computational and drawing software. The university's pre-installed Gaussian 03 software, the ChemSketch freeware, ChemDraw Ultra 8.0, and Chem3D Ultra 8.0 software were also used. A wide variety of compounds were studied in order to undergo molecular optimization calculations with the Gaussian 03 software.³ Selected compounds in Figure 4 were analyzed in this research. The compounds of major focus in this study are vanillylacetone **1**, benzylacetone **3**, and reactive enolates **2** and **4** (Figure 3). Graphical representations of energy transitions were constructed for stability analysis. The calculations were logged in the university's WebMO graphical user interface service. An optimized synthetic approach will be proposed based on the results of the calculations.

Effect of Fluorine and Its Reactivity

Fluorine exhibits many physiochemical properties that can enhance a compound's reactivity in *in vivo* biological systems. The unique physical properties of fluorinated compounds derive, in part, from the extreme electronegativity of fluorine. The carbon-fluorine bond (C-F) is a polar bond in organic chemistry with a relatively large dipole moment compared to that of a carbon-hydrogen bond (C-H). A C-F bond is polarized in the opposite direction to a C-H bond, and is more stable (by about 14 kcal/mol) and polarizable than a C-H bond.⁴ The C-F bond (1.4 Å) is significantly longer than a C-H bond (1.0 Å). Nevertheless, fluorine can frequently be substituted for hydrogen in very small nonpolar molecules, with minimal impact on their binding to proteins and enzyme complexes.⁴ Fluorinated R-groups in specific hydrophobic and basic amino acid sequences of proteins exhibit a hydrophobic effect in water and have been shown to exhibit chemical and thermal stabilization in secondary and tertiary protein structures due to hydrophobic interactions.⁴ Fluorine has a binding affinity with lysine, arginine, histidine, valine, leucine, and isoleucine. Such fluorinated protein analogues exhibit increased chemical and thermal stability towards the protein unfolding by chemical denaturants, solvents, heat, and degradation by protease or ubiquitin mediated complexes.⁴ Overall, fluorinated compounds display an enhancement of thermal stability (C-F ~ 107 Kcal/mol), an increase of lipophilicity and hydrophobicity, increasing bioavailability, and the capability of mimicking enzyme substrate complexes.⁵ Fluorinated compounds dissolve in highly acidic conditions, such as the gastrointestinal tract, and exert their physiochemical properties for their desired mechanisms of action.

Quantum Computational Chemistry

Computational chemistry has become a useful way to investigate materials and compounds that are too difficult to find or too expensive to purchase. This helps researchers make predictions before running the actual experiments so they can be better prepared for making observations. Computational chemistry and its applications are based on the Born-Oppenheimer approximations to function in the simplification of the

Schrodinger equation. The Schrodinger equation is a partial differential equation that describes how the quantum state of a quantum system changes with respect to time.⁶ Therefore, the Schrodinger equation is time-dependent. The equation is not a simple algebraic equation, but a linear partial differential equation that describes a system's electronic wave functions and configurations. The equation describes a single particle of mass moving with energy in one dimension. The particle does not have a precise trajectory; instead there is only a probability that it may be found at a specific location at any instant.⁶ Erwin Schrodinger's quantum mechanical systems state that the laws of motion and the quantum conditions are deduced from the Hamiltonian operator (\hat{H}).⁶ The Hamiltonian operator corresponds to the total energy of the system considering the sum of the kinetic and potential energies of the system.

A definite localization of the electric charge in space and time can be associated with the wave-system and can account for electrodynamic principles for frequency, intensity, and polarizations of emitted light.⁶ The equation and its adjusted approximations by Hartree-Fock theory measure the probability distributions of electrons in space. However, there is a level of uncertainty to these methods and theories. First, in classical Newtonian mechanics, a particle has an exact position and an exact momentum. In quantum mechanics, Werner Heisenberg states that a particle may have a definite position, but a definite velocity or momentum cannot be known to be precise.⁷ The Schrodinger equation cannot supply a specific measurement of the wave function even if the wave function is known exactly. Only predictions and approximations can be made.

Other approximation methods are made by Born and Oppenheimer to simplify the Schrodinger equation. The Born-Oppenheimer approximation simplifies the Schrodinger equation by noting that the position of the atomic nucleus remains relatively constant due to the nucleus having a mass larger than that of the oscillating electrons. The Born-Oppenheimer equations neglect the velocities of nuclei, and the nucleus is assumed to be stationary while electrons move around it. The motion of the nuclei and the electrons can be separated, and the electronic and nuclear configurations can be solved with independent wave functions.⁸ Quantum mechanical methods are suitable for calculating molecular orbital energies and coefficients, heats of formation of specific conformations, partial atomic charges, electrostatic potentials, dipole moments, transition-state geometries and energies, and bond dissociation energies.

Ab Initio Method of Calculation

Ab initio methods involve performing molecular dynamics calculations on a system of nuclei without prior knowledge of the quantum mechanical potential energy surface.⁹ These calculations account for the potential energy difference of electrons in the excited states altogether. The minimum basis set for atomic orbitals follows the STO-3G basis set for Gaussian integrals (Figure 5). STO-3G stands for Slater-type orbital (STO) and measures the three Gaussian orbitals (1s, 2s, and 2p). Slater-type Orbitals are accurate; however, it requires longer to calculate integrals using STO basis sets. Instead, Gaussian integrals are computed to approximate the STO values by STO-nG basis sets. Therefore, quantum chemists and physicists use a linear combination of enough Gaussian-type Orbitals (GTOs) to mimic a STO basis set (Figure 6). In quantum

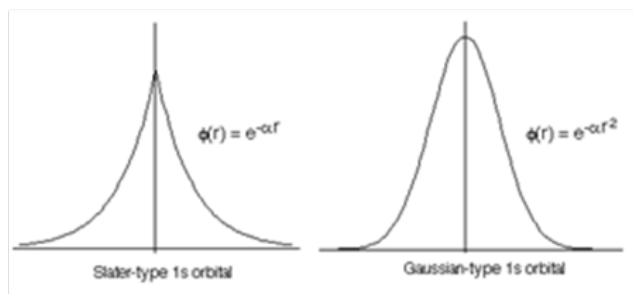


Figure 5. STO-1s vs. GTO-1s basis functions.¹¹

chemistry, the basis set usually refers to the set of one-particle functions used to build molecular orbitals from atomic orbitals, where an orbital is a one-electron function. The primitive Gaussian functions (ϕ_i) are represented by the core and valence electrons surrounding the central atom. This basis set works for large systems in *ab initio* methods used primarily for geometric optimizations. This method, observed in Figure 6, involves

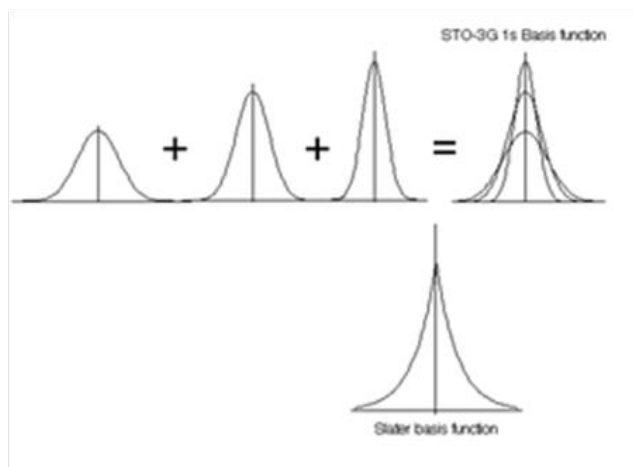


Figure 6. STO-3G basis function.¹¹

approximating the Gaussian integrals of an STO-3G basis set with fitting functions in order to decrease the computational costs of evaluating the energy and forces during molecular simulations.⁹ This method is an *ab initio* one and will give results with accuracy similar to those obtained from an STO-3G calculation. It can easily be extended to larger basis set calculations like 6-311G (p,d,f) as well.⁹ The *ab initio* calculations performed follow the general Hartree-Fock theory in conjunction with a standard Gaussian basis set (STO-3G). The Hartree-Fock theory states that an electron's motion is a single-particle function or Slater orbital that does not depend on the instantaneous motions of the other electrons.¹⁰ The Hartree-Fock (HF) theory essentially is another approximation to the Schrodinger equation that expresses the total wave function of a system as a product of one electron occupied in atomic orbitals. The motions of all other electrons are taken as an average distribution only.

Previous Synthesis and Research

A previous study of [6]-2,2-difluorogingerol used the trifluoroacetate release method to generate highly reactive intermediates, but the study did not yield the desired difluorinated gingerol intermediate **2** in Figures 3 and 7.¹² The trifluoroacetate release strategy was developed at Purdue University and is proven to generate reactive intermediates for a variety of compounds.¹² The researchers describe the application of the trifluoroacetate-release strategy to cleave a carbon-carbon bond and generate α , α -difluoroenolates. This method uses exceedingly mild reaction conditions, is not limited to a small group of fluorinated building blocks, and is compatible with many substrates.¹² The problem with the previous synthesis was the first step of the reaction. The previous synthesis by method of trifluoroacetate release to generate [6]-2,2-difluorogingerol by carbon-carbon selective cleavage strategy through a sequential aldol condensation reaction did not yield as anticipated. Molecular optimization of the reaction conditions and intermediates can be made to provide molecular and quantum-based calculations for better geometric optimizations and compound stability. Figure 7 illustrates the four step synthesis performed in previous works. The problem encountered occurred in the first step of the reaction involving vanillylacetone **1** and base LiHMDS to produce intermediate **7**.

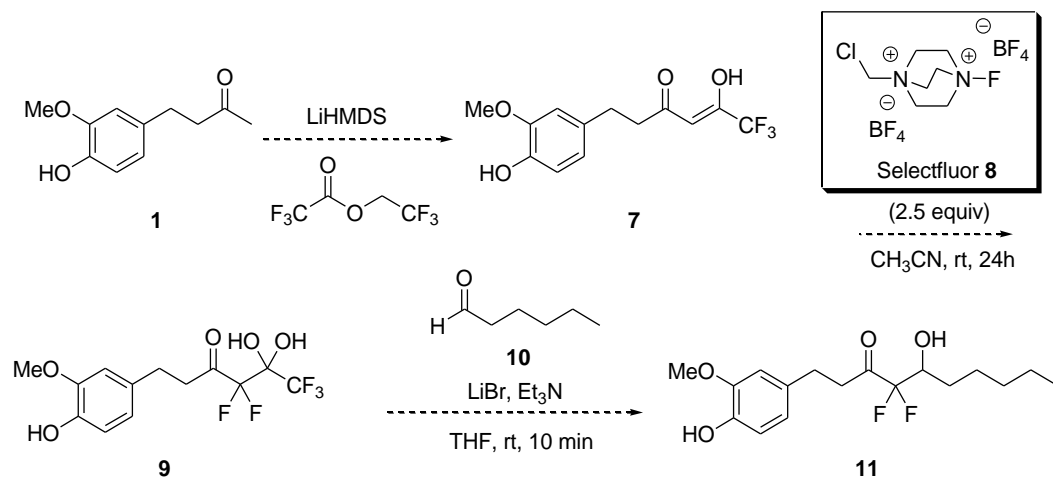


Figure 7. Attempted synthesis of [6]-2,2-difluorogingerol through trifluoroacetate release strategy.¹¹ (Structures produced from ChemDraw Ultra 8.0 and ChemSketch Freeware)

Results and Discussion

The two first-step reactions in Figures 8 and 9, in which a base such as LiHMDS (Figure 3) requires energy to deprotonate a hydrogen atom at the alpha carbon, are nonspontaneous processes as indicated by Hess's Law. The reactions are endergonic/endergonic, indicating that energy is absorbed or required for deprotonation of the hydrogen atom to occur. The H⁺ ion has no energy (0 Hartree) since there are no electron interactions at the electron-deficient hydrogen atom. The reaction in Figure 8 has a net Gibbs free energy of +0.815999 Hartree (~ +2,142.41 kJ/mol) and an activation energy of +0.81426 Hartree (~ +2137.84 kJ/mol). The

reaction in Figure 9 has a net Gibbs free energy value of +0.739635 Hartree ($\sim +1941.9$ kJ/mol) and an activation energy of +0.741383 Hartree ($\sim +1946.5$ kJ/mol). Therefore, the reaction in Figure 8 has a higher activation energy than the reaction in Figure 9 and is still a nonspontaneous process. The selection of a very strong base is required for deprotonation at the alpha carbon position.

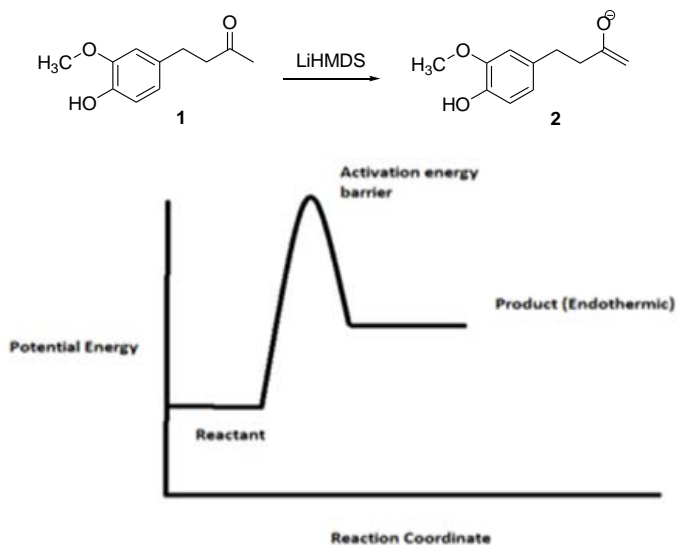


Figure 8. Energy diagram for vanillylacetone **1** and intermediate **2** under reaction with base LiHMDS. Activation energy: +0.81426 Hartree (+2,137.84 kJ/mol), Gibbs Free energy: +2,142.41kJ/mol.

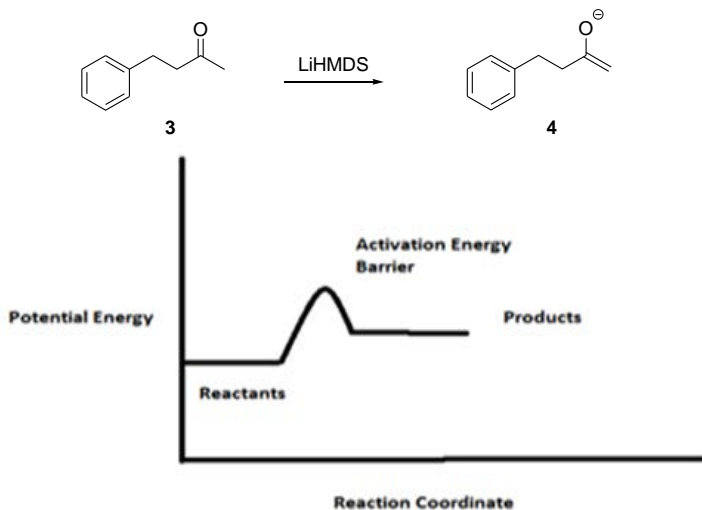


Figure 9. Energy diagram for benzylacetone **3** and intermediate **4**, respectively. Activation energy: +0.741383 Hartree (+1946.5 kJ/mol), Gibbs Free energy: +1941.9 kJ/mol.

The reaction in Figure 8 may have a large activation barrier; however, it is the preferred reaction since the desired difluorinated gingerol compound requires vanillylacetone as the starting material. With vanillylacetone as the starting reactant, the end product 2,2-difluorogingerol contains the two phenyl R groups required for the desired course of action.

In terms of calculating energy values for small molecules, the greater the number of atoms, the lower the energy values and the greater the stability. Molecules with a lower number of atoms correspond to higher energy values and greater reactivity as evident in Figures 10 and 11. The basis set for calculations on the Gaussian 03 software followed a 6-311+G(2p) basis set for vanillylacetone **1** and benzylacetone **3** (Figures 10 and 11).³ The basis set for intermediates **2** and **4** followed a 6-31G(d) basis set (Figures 10 and 11).³ The difference in basis sets for each compound lies in the outer electron calculation. Vanillylacetone **1** and intermediate **2** are very stable compounds and not as reactive based on the calculated data. Benzylacetone **3** and intermediate **4** are very reactive compounds and more likely than not can undergo the reaction with the conditions outlined in Figure 7. It is reported that benzylacetone **3** underwent mild trifluoroacetate release via carbon-carbon selective cleavage to yield a difluorinated end product.¹² Vanillylacetone **1** (Figure 3), however, did not undergo the reactions to yield difluorinated enolates or products. The chemical structure and identity of [6]-gingerol in Figures 1 and 2 encompass the two phenyl groups attached to the compound that are important for [6]-gingerol's medicinal activity. The presence of the two phenyl groups (-OCH₃ and -OH) on [6]-gingerol, observed in Figures 1 and 2, is crucial for the activation of the aromatic benzene ring in [6]-gingerol and the compound's medicinal activity. Both -OCH₃ and -OH groups are electron-donating substituted R groups that function in the activation of the aromatic benzene ring.

The problem in the synthesis in previous works was that the initial step in the formation of the enolate did not work. The base LiHDMS is a weak, sterically hindered base that did not deprotonate the hydrogen atom at the α_2 carbon position. In organic chemistry, generation of enolates occurs when a strong or relatively strong nucleophilic base deprotonates a hydrogen atom at the α carbon position. The α carbon is adjacent to the carbonyl (C=O) group. There are two carbon atoms adjacent to the carbonyl group, which poses a problem as illustrated in Figure 12. A stronger and less bulky base must be used to deprotonate the hydrogen atom at the α_2 position so Zaitsev's rule cannot be satisfied. Zaitsev's rule states or predicts that in an elimination reaction, the most stable alkene is the most substituted carbon atom. This reaction with base is not a β -elimination reaction, but a reaction involving the formation of enolates. Instead, for a future synthesis, nBuLi base will be added to vanillylacetone and will deprotonate at the α_2 position. The reaction must occur at low temperature as deprotonation will occur faster than at high temperatures. The base nBuLi illustrated in Figure 13, is a very strong, non-sterically hindered base that will deprotonate and result in the formation of a kinetically preferred reactive enolate shown in Figure 12.

Route	#N B3LYP/6-311+G(2d,p) FREQ Geom=Connectivity POP=FULL												
Geometry Sequence	<table border="1"> <thead> <tr> <th>Step</th> <th>Energy</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>-463.657778875</td> </tr> <tr> <td>Animation speed</td> <td>5</td> </tr> <tr> <td>Loop</td> <td>None</td> </tr> </tbody> </table>	Step	Energy	0	-463.657778875	Animation speed	5	Loop	None				
Step	Energy												
0	-463.657778875												
Animation speed	5												
Loop	None												
Stoichiometry	C ₁₀ H ₁₂ O												
Symmetry	CS												
Basis	6-311+G(2d,p)												
B3LYP Energy	-463.657778875 Hartree												
ZPE	0.192868 Hartree												
Conditions	298.150K, 1.00000 atm												
Internal Energy	-463.455717 Hartree												
Enthalpy	-463.454773 Hartree												
Free Energy	-463.500202 Hartree												
C _v	35.849 cal/mol-K												
Entropy	95.613 cal/mol-K												
Rotational Constants	<table border="1"> <thead> <tr> <th>Constant</th> <th>Frequency (GHz)</th> <th>Frequency (cm⁻¹)</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>3.41384</td> <td>0.11387344508</td> </tr> <tr> <td>b</td> <td>0.46593</td> <td>0.01554175189</td> </tr> <tr> <td>c</td> <td>0.41306</td> <td>0.01377819852</td> </tr> </tbody> </table>	Constant	Frequency (GHz)	Frequency (cm ⁻¹)	a	3.41384	0.11387344508	b	0.46593	0.01554175189	c	0.41306	0.01377819852
Constant	Frequency (GHz)	Frequency (cm ⁻¹)											
a	3.41384	0.11387344508											
b	0.46593	0.01554175189											
c	0.41306	0.01377819852											
Dipole Moment	2.5401 Debye												
Stoichiometry	C ₁₁ H ₁₃ O ₃ (1-)												
Symmetry	C1												
Basis	6-31G(d)												
B3LYP Energy	-652.644709812 Hartree												
ZPE	0.218128 Hartree												
Conditions	298.150K, 1.00000 atm												
Internal Energy	-652.412652 Hartree												
Enthalpy	-652.411708 Hartree												
Free Energy	-652.468713 Hartree												
C _v	52.363 cal/mol-K												
Entropy	119.978 cal/mol-K												
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Constant	Frequency (GHz)	Frequency (cm ⁻¹)											
a	1.32734	0.04427529661											
b	0.31696	0.01057264756											
c	0.26805	0.00894118557											
Dipole Moment	14.9511 Debye												

Figure 10. *Ab initio* calculations for vanillylacetone **1** and intermediate **2**, respectively.³ (Results provided by WebMO services and Gaussian 03 software)

Geometry Sequence													
Step	Energy												
0	-653.470468979												
Animation speed	5												
Loop	None												
Stoichiometry	C ₁₁ H ₁₄ O ₃												
Symmetry	C1												
Basis	6-311+G(2d,p)												
B3LYP Energy	-653.470468979 Hartree												
ZPE	0.229807 Hartree												
Conditions	298.150K, 1.00000 atm												
Internal Energy	-653.225968 Hartree												
Enthalpy	-653.225024 Hartree												
Free Energy	-653.284712 Hartree												
C _v	53.494 cal/mol-K												
Entropy	125.625 cal/mol-K												
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Constant	Frequency (GHz)	Frequency (cm ⁻¹)											
a	1.34874	0.04498912378											
b	0.29220	0.00974674286											
c	0.25859	0.00862563394											
Dipole Moment	3.1144 Debye												

Stoichiometry	C ₁₀ H ₁₁ O(1-)												
Symmetry	C1												
Basis	6-31G(d)												
B3LYP Energy	-462.904475336 Hartree												
ZPE	0.180943 Hartree												
Conditions	298.150K, 1.00000 atm												
Internal Energy	-462.713390 Hartree												
Enthalpy	-462.712446 Hartree												
Free Energy	-462.760567 Hartree												
C _v	38.721 cal/mol-K												
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Constant	Frequency (GHz)	Frequency (cm ⁻¹)											
a	3.30915	0.11038136256											
b	0.47979	0.01600407172											
c	0.44771	0.01493399811											
Dipole Moment	12.3519 Debye												

Figure 11. *Ab initio* calculations for benzylacetone **3** and intermediate **4**, respectively.³ (Results provided by WebMO services and Gaussian 03 software)

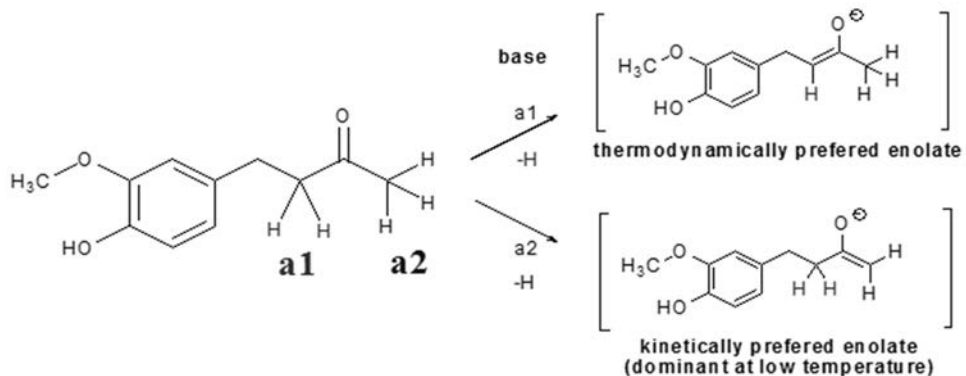


Figure 12. Deprotonation by base yields two possible temperature dependent enolate intermediates. (Structures produced by ChemDraw Ultra 8.0 software)

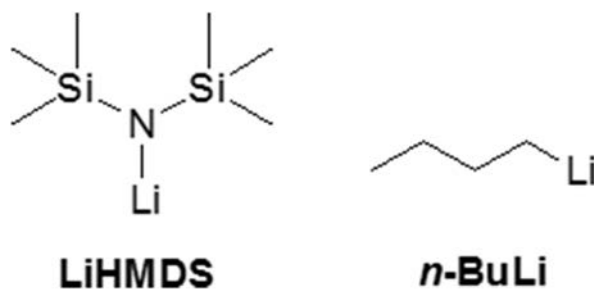


Figure 13. Structures of LiHMDS and n-BuLi nucleophilic bases, respectively. (Structures produced by ChemDraw Ultra 8.0 software)

Conclusions

This computational study for optimizing the multi-step synthesis of 2,2-difluorogingerol incorporated approximations in quantum mechanics to determine the energy values for various compounds and intermediates in Figures 3 and 4. The general Hartree-Fock *ab initio* method performed calculations on 6-311G(p,d) basis sets to approximate Slater-type Orbital (STO) functions by fitting Gaussian functions to decrease the computational costs.⁹ While the computational calculations extend to all compounds in Figure 4, this study focuses on the compounds in Figure 3. Vanillylacetone **1** is more stable than benzylacetone **3** (Figure 3) due to smaller (ΔG) Gibbs energy value. A large activation energy barrier is observed when vanillylacetone **1** is converted to an enolate intermediate **2** upon deprotonation by base LiHMDS (Figure 8). A small activation energy barrier is observed when benzylacetone **3** is converted to

enolate intermediate **4** upon deprotonation by base LiHMDS (Figure 9). The initial hypothesis states that in the second step of the organic synthesis, the presence of the phenylhydroxy group (-OH group) and phenylmethoxy group (-OCH₃) in vanillylacetone **1** (Figure 3) is what accounts for the low percent yield of the desired difluorogingerol end product when undergoing the reaction conditions in Figure 7. It is suspected that the starting material vanillylacetone **1** is too stable and not very reactive. The hypothesis is accepted and proven correct based on computational data in Figures 10 and 11. The reaction whereby benzylacetone **3** is converted to intermediate **4** under the same conditions in Figure 7 succeeded in yielding a difluorinated end product.¹² The reaction works well for benzylacetone **3** as the starting material in Figure 3 but not vanillylacetone **1**. To correct this, a stronger base such as n-BuLi (Figure 13) can be substituted for LiHMDS (Figure 13). Vanillylacetone **1** (Figure 3) is the preferred starting material as it contains electron-donating R groups that activate the aromatic benzene ring responsible for [6]-gingerol's (Figure 2) medicinal activity. An optimization of the reaction pathway to achieve a difluorinated gingerol compound is well underway.

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Glucophage® (Metformin Hydrochloride), the Wonder Drug: A Biguanide Class Treatment of Type 2 Diabetes

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Abstract

Diabetes is a disease that has been around for a very long time—from as far back as the ancient Egyptians. The disease does not have just one straightforward etiology, since there are several different types of diabetes. Type 2 diabetes affects at least 10 percent of the United States population, and one of the most recommended drugs in treating type 2 diabetes is metformin. Synthesized from a naturally occurring flower that had been used in the past to treat the symptoms of diabetes, metformin has many positive effects, including lowered hemoglobin A1c levels (HbA1c), weight reduction, and a lowered risk of heart attack. Metformin can also be used in treating other conditions, such as polycystic ovarian syndrome and cancer. Current research is even exploring metformin's ability to counteract aging. The exact mechanism of metformin is still being researched, but it is believed that the center of metformin's action is an alteration of the energy metabolism of the cell.

Introduction

Metformin is a member of the biguanide class of drugs and is used in treating a number of diseases and conditions, of which type 2 diabetes is most prevalent. Type 2 diabetes is characterized by abnormally high levels of glucose in the blood due to either insulin resistance of the cells or too much glucose production in the liver or a combination of both.

Metformin's mechanism of action is related to increasing the activity of energy sensor adenosine-monophosphate-activated protein kinases, which increases glucose uptake in various tissues, increases lipid metabolism, and decreases glucose production in the liver.^{1,2,3} Thus metformin lowers blood glucose concentrations but also increasingly seems to produce a host of other beneficial effects in both diabetics and non-diabetics.

History and Epidemiology

Diabetes is an old disease, and can be found recorded as far back as 1500 BCE by Egyptian physicians.⁴ Until the 1920s, when Banting and Best discovered how to extract and purify insulin, there was no efficacious treatment for diabetes.⁵

The different manifestations of diabetes include type 1 diabetes mellitus (T1D), type 2 diabetes (T2D), gestational diabetes mellitus, maturity-onset diabetes of the young, endocrinopathies, and diseases of the pancreas such as pancreatic cancer or pancreatitis. They all have differences in underlying pathogenesis, but the unifying theme is that when untreated they all result in chronic hyperglycemia.⁶

From 1980 to 2014, the rate of diabetes increased from 4.3% to 9.0% in men, and from 5.0% to 7.9% in women, to affect a total of 382 million people around the world.^{7,8} In the United States, T2D affects 29.1 million people or 9.3% of the total population, according to the Centers for Disease Control and Prevention.⁹ Factors contributing to this rising epidemic include aging, population growth, increasing urbanization, increasing incidence of obesity, and more inactive lifestyles.^{7,10} However, T2D is only one classification of the many maladies that fall under the umbrella of diabetes.

T2D accounts for approximately 90% of all diabetic cases and is a condition in which the blood is hyperglycemic. Patients with T2D do not need insulin to survive but may present with varying severity of pathophysiologies ranging from predominantly insulin resistant with relative insulin deficiency to predominantly insulin secretory defect with some insulin resistance.²¹ Setter and fellow researchers (2003) described T2D as “characterized by three pathophysiologic abnormalities: relative insulin deficiency, insulin resistance involving myocytes and adipocytes, and hepatic insulin resistance” which result in increased gluconeogenesis and impaired glycogen synthesis.¹¹ The risk of developing this form of diabetes increases with old age, obesity, and inactivity. It has ties with different ethnic groups and is also presumed to have a stronger association to genetics than the autoimmune form of diabetes, T1D.⁴

Untreated chronic hyperglycemia that results from T2D can result in severely detrimental side effects. These include nephropathy, neuropathy, retinopathy, and macrovascular complications. Of all deaths in patients with T2D, 80% involve cardiovascular disease or stroke, reflecting the macrovascular complications of the disease. Cardiovascular abnormalities can be a result of other factors, including obesity, lipid abnormalities, hypertension, hypercoagulation, platelet dysfunction, and endothelial dysfunction.¹¹ Neuropathy can potentially result in limb amputation; retinopathy can lead to blindness; and nephropathy leads to end-stage renal disease and the need for renal dialysis or transplants. Delaying or preventing these complications are primary goals in treating diabetes.¹²

In 1936 Harold Himsworth differentiated between insulin-sensitive and insulin-resistant types of diabetes.¹³ This discovery opened the door for the array of T2D or insulin-resistant diabetic treatments. Drugs currently on the market for treating T2D include, but are not limited to, sulfonylureas, thiazolidinediones, biguanides, incretin mimetics, peroxisome proliferator-activated receptor gamma (PPAR γ), and α -glucosidase inhibitors.¹⁴ The oldest of these drugs are the sulfonylureas, which were the primary treatment for T2D before metformin. The American Diabetes Association

(2014) recommends treating a patient with T2D by starting with lifestyle modifications such as diet and exercise.¹² Although these modifications are important, they are rarely completely efficacious in treating hyperglycemia. T2D is a progressively degenerative disease that worsens with age and involves progressive beta-cell functional decline. It is important to reassess patients every few months, whatever medication(s) they may be on.¹⁵

Sulfonylureas

Sulfonylureas were the primary treatment for T2D before metformin and now are sometimes used in combination with metformin.⁶ Carbutamide was a first-generation member of the sulfonylurea family and was discovered in 1942 to be effective in treating hyperglycemia. However, carbutamide had adverse effects on bone marrow and so was withdrawn from the market.¹⁴ In the 1960s, later generations of sulfonylureas were shown to be no more effective in treating T2D than diet and exercise, and thus were recommended as a first line of treatment in newly diagnosed patients.¹⁶ Second-generation sulfonylureas with no adverse effects on the heart or bone are now on the market and possess effective mechanisms of lowering blood glucose concentrations.¹⁴

Sulfonylureas work as K⁺ channel blockers and result in an increase of insulin secreted from the pancreatic β cells into the plasma, regardless of the concentration of blood glucose.¹⁴ In addition to their effects on pancreatic β cells, sulfonylureas increase receptors for insulin on monocytes, adipocytes, and erythrocytes when the patient receives chronic treatment.¹⁷ Depending on the generation, sulfonylureas are usually taken once a day with increasing dosages as needed and have an active duration of from 8-24 hours.¹⁸

The major limitation of sulfonylureas, especially with the longer-acting agents such as glyburide and chlorpropamide, is their high risk for hypoglycemia because they increase insulin secretion regardless of how much insulin is already in the blood.

Metformin

Metformin is in the class of biguanides and is currently a first-line treatment for T2D.^{4,15,19,20} It is not insulin but is considered an insulin sensitizer.^{21,22} It is in the biguanide family, isolated from the flower *Galega officinalis*, commonly known as goat's rue, and was used to treat diabetes in the medieval period because it relieved the intense urination.⁵ In 1922 guanidine was found to be the active ingredient in *Galega officinalis* that lowered blood glucose levels.²³ Phenformin and buformin were synthesized as part of the biguanide class in the 1950s, but were withdrawn in the 1970s because of increased incidences of death due to lactic acidosis and cardiac dysfunctions resulting from use of phenformin in treating those with T2D.^{23,24} Metformin was part of the next generation of biguanides, and in 1995, after 20 years on the market in the United Kingdom (UK), it was approved for use in the United States because it did not have the same toxic effects as phenformin.^{5,23} The guanidine structure of metformin is a nitrogenous analog of carbonic acid, and includes two methyl groups, whereas phenformin and buformin have apparently toxic aromatic rings or alkyl chains. In Figure 1, the differences between phenformin and metformin can be observed.

Metformin has a greater association with reductions in weight and low-density lipoprotein (LDL) cholesterol, and a much lower risk of hypoglycemia when compared with sulfonylureas and with thiazolidinediones, a newer option in treating T2D.^{20,26}

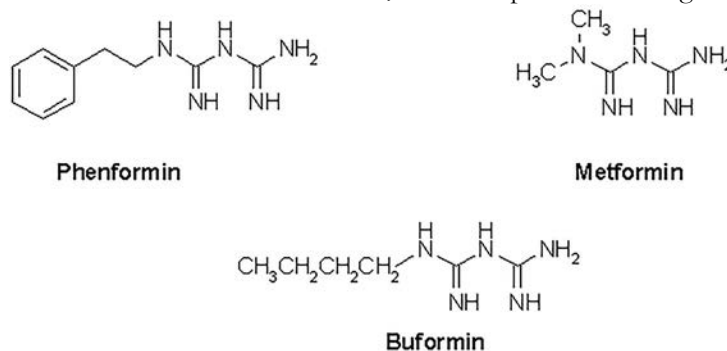


Figure 1. Differences in structure between phenformin, metformin, and buformin.²⁵

Metformin carries a low risk of hypoglycemia because its primary action is inhibition of gluconeogenesis, the liver's production of glucose from non-carbohydrates such as proteins or fats. In contrast, the effect of most other T2D drugs is to stimulate insulin secretion. Metformin's beneficial effect on diabetes is dependent on there being circulating insulin in the blood.²⁷ Thus it cannot be a substitute for insulin or the only treatment in insulin-dependent diabetes such as T1D. Metformin is indicated in treating insulin-resistant classes of diabetes, such as T2D or gestational diabetes.

When compared against placebo effect or insulin, metformin also decreases cardiovascular mortality rates.^{3,28} Along with these effects, metformin provides protection against nephropathy, heart disease, and polycystic ovarian syndrome, and a significant reduction in cancer risk.³

Development of Metformin

The botanical *Galega officinalis*, as previously mentioned, was given to diabetic patients because it relieved the excessive urination symptom. The plant is also known as French lilac or Italian fitch, and was given to patients during plague epidemics to promote perspiration.⁵ Further research showed that the active ingredient in French lilac that resulted in lowering of blood glucose was galegine, or isoamylene guanidine.²⁸ Metformin is a substituted biguanide synthesized from the guanidine active principle and is shown in Figure 2a and Figure 2b. Metformin's official chemical name is N,N-dimethylimidodicarbonimidic diamide (also called 1,1-dimethylbiguanide), and its formula is C₄H₁₁N₅.²⁹

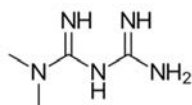


Figure 2a. Molecular structure of metformin.²⁹

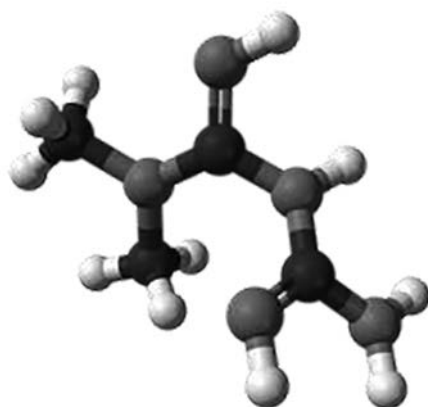


Figure 2b. Ball-and-stick model of metformin.²⁹

Metformin was first described in 1922 by Werner and Bell, and it involved a simple precipitation reaction of dimethylamine hydrochloride and 2-cyanoguanidine over heat. This synthesis can be seen in Figure 3. More reactions to produce metformin have been described and patented. Metformin hydrochloride, the salt version of the drug, is synthesized via the reaction of equimolar amounts of dimethylamine and 2-cyanoguanidine dissolved in toluene with cooling to make a concentrated solution, with equimolar amounts of hydrogen chloride slowly added. The mixture boils and then, after cooling, metformin hydrochloride is yielded in a precipitate with 96% yield.^{30,31}

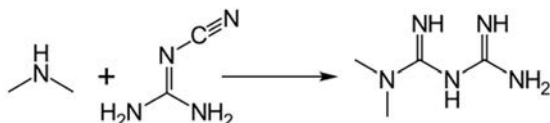


Figure 3. Synthesis of metformin first performed by Werner and Bell.³⁰

In 1929 metformin was shown to lower blood glucose concentrations in rabbits and was the most efficacious out of all the biguanides studied simultaneously, but this discovery was overshadowed by the breakthrough of extracting and purifying insulin around the same time. Metformin was approved for the US pharmaceutical market in 1995, after recognition of the acidosis risk of phenformin, another member of the biguanide family.³²

The dosage of metformin is usually 1-3 pills per day at different sizes of 500 mg, 850 mg, or 1000 mg, taken with meals in order to reduce adverse gastrointestinal side effects.²² The dosage is usually changed when taken in combination with other drugs. Metformin can be used concomitantly with other drugs such as glipizide, glyburide, rosiglitazone, pioglitazone, repaglinide, sitagliptin, and insulin to create beneficial glucose-lowering effects.³³

Testing and Clinical Trials

Organic Cation Transporter

Shu and colleagues (2007) performed testing on hepatic tissues *in vitro* and in mice *in vivo*, showing that the organic cation transporter-1 (OCT1) is important in metformin activity.¹ The researchers determined that, in primary cultures of mouse hepatocytes, elimination of *Oct1* gene reduced the response to metformin. And *in vivo* testing in mice showed that OCT1 was required for metformin to lower blood glucose levels. They also observed in humans that OCT1 polymorphisms modulated cellular and clinical responses to metformin, and concluded that OCT1 mediates the first step in the response pathway of metformin.¹ Thus, changes in *Oct1* expression, or prevalence, may change the effectiveness of metformin in humans.³

Type 2 Diabetes

Various clinical trials have shown that metformin has many more positive effects than simply lowering HbA1c levels, which it was originally used to do. Metformin has also been shown to decrease cholesterol levels, reduce weight, and prevent death due to cardiovascular disease (CVD).²²

Metformin's glucose-lowering capability is related to its ability to perform a long list of functions. Metformin improves glucose metabolism and insulin action by having a positive effect on insulin receptor expression as well as tyrosine-kinase activity.^{2,3} Metformin's binding interactions result in increased adenosine monophosphate (AMP)-activated protein kinase (AMPK) activity, which increases adenosine triphosphate (ATP)-generating pathways and decreases the ATP-consuming pathways. AMP and ATP are involved in regulating certain biochemical cellular processes, such as lipid metabolism, membrane transport and cell proliferation. The binding interactions increase mitochondrial biogenesis and lipid oxidation, as well as insulin sensitivity.³¹

AMPK is activated by metformin's binding to the respiratory chain complex.^{34,35} El-Mir, Nogueira, and Fontaine (2000) discovered "the treatment by dimethylbiguanide *in vivo* or *in vitro* (in intact isolated hepatocytes) affects the mitochondrial respiratory chain specifically at the complex I site," and isolation of the other protein complexes in the respiratory chain did not prove effective. They also concluded, by testing *in vitro* hepatocytes, that reactive oxygen species (ROS) scavengers had no effect on metformin nor on its action.³⁵

Testing also showed that metformin increases plasma levels of glucagon-like peptide 1 (GLP1), which helps with insulin signaling.³⁶ GLP1 is secreted from the gut in response to ingestion of food. In people not suffering from diabetes, GLP1 stimulates insulin secretion, while in T2D patients GLP1 activity is not efficient or it is suppressed.³⁷

Howlett and Bailey (1996) assert that metformin has been shown not only to lower blood glucose concentrations, but also to positively impact lipids and triglyceride levels in the blood in patients with T2D. It can produce a 10 to 20 percent reduction in plasma triglyceride levels in non-hypertriglyceridemic patients and up to 50 percent triglyceride reduction in hypertriglyceridemic patients, a 10 percent decrease in total cholesterol levels, an increase of 17 percent in high-density lipoprotein (HDL) levels, and a 25 percent decrease in low-density lipoprotein (LDL) levels.³⁸

Metformin is beneficial in reducing cholesterol not only in diabetic patients but non-diabetics as well. Carlsen and colleagues (1996) noticed a 12 percent decrease in lipid levels over a 12-week period and reported that “metformin, given for 12 weeks as a supplement to lovastatin, diet and lifestyle advice to non-diabetic male patients with coronary heart disease, further improves the lipid pattern in normal weight patients, and reduces weight in the overweight patients.”³⁹

Ilamanna and fellow researchers (2011) concluded that, in reducing CVD risk, metformin was more beneficial in its effects on cardiovascular events in trials that had longer lengths with younger participants, and that the greatest benefit of metformin in reducing CVD and all-cause mortality derives from its glucose- and lipid-decreasing factors.⁴⁰ According to Bristol-Myers Squibb, the company that markets Glucophage, other studies have shown more concrete evidence that metformin significantly decreases CVD mortality risk.³⁵

According to Raficjan-Kopaei and Baradaran (2013), metformin may have renoprotective qualities as well.⁴⁰ Glycosuria, a condition characterized by high levels of glucose in the urine is harmful to the renal tubules because it can disrupt the filtering capabilities of the glomeruli and lead to kidney damage. Metformin decreases incidences of glycosuria and also possesses antioxidant effects, which contribute to less damage in the kidneys.⁴¹

As of 2012, metformin is not indicated as a weight-loss drug, even though studies have shown that metformin reduces weight and can prevent the development of T2D.^{42,43} The Diabetes Prevention Program Research Group (2012) administered a study on approximately 3,200 participants who were classified as pre-diabetic, which means that they had impaired glucose tolerance of 140-199 mg/dL and impaired fasting glucose of 95-125 mg/dL. The participants also had to meet certain BMI and age criteria. The researchers randomly separated participants into two groups, one receiving metformin and the other a placebo. Those in the metformin group saw a 3.5 percent weight reduction and lost at least 2 cm from their waist circumference over a period of 2 years.⁴²

Type 1 Diabetes

According to Lund and colleagues (2009), patients with T1D that have poor glycemic control have just as much risk for cardiovascular disease and dyslipidemia, thus they benefit equally from metformin therapy. In a randomized controlled study of one-year length, 100 subjects with T1D and poor glycemic control were given adjunct metformin therapy in combination with insulin or other drugs. Overall, the subjects involved in the study had a decrease of 0.3 mmol/L in both total and LDL cholesterol. The results in HDL cholesterol were not significant, however.⁴⁴

Other studies show similar results. Abdelghaffar and Attia (2009) observe that “studies done in type 1 diabetes demonstrated different combinations of the following: reduction of glycosylated hemoglobin A1c, increased insulin sensitivity, decreased dosage of insulin, decreased body mass index, and improvement of lipid profile.”⁴⁵ The safety of metformin in T1D may be questionable because the drug comes with a higher risk for lactic acidosis and hypoglycemia than when used as treatment in patients with T2D. The main effect of metformin in T1D is most likely due to its insulin-sensitizing effect, in contrast to metformin’s effect in T2D in contributing to decreased hepatic glucose output.⁴⁶

Contraindications and Side Effects

The main concerns with any available treatment for diabetes include hypoglycemia and diabetic ketoacidosis. Diabetic ketoacidosis (DKA) as a result of prolonged elevation of glucose in the blood is a very serious state. It includes severe dehydration from a combination of loss of electrolytes, sweating, hyperventilation, and fever, as well as includes cardiac and skeletal muscle toxicity.⁴⁷ DKA can be easily avoided with close monitoring of blood glucose levels. One out of 33,000 patients taking Glucophage reports incidences of DKA in a year.²² According to Cusi and Defronzo (1998), “Unlike phenformin (a precursor to metformin of the biguanide family), metformin does not adversely affect mitochondrial lactate oxidation and therefore does not cause lactic acidosis unless plasma concentrations of metformin are excessive.”²⁴

Adverse Reaction	GLUCOPHAGE Monotherapy (n = 141)	Placebo (n=145)
Diarrhea [†]	53.2	11.7
Nausea/Vomiting	25.5	8.3
Flatulence	12.1	5.5
Asthenia	9.2	5.5
Indigestion	7.1	4.1
Abdominal Discomfort	6.4	4.8
Headache	5.7	4.8

Table 1. Most common adverse reactions (>5.0 percent) in a placebo-controlled clinical study. Numbers listed as percentages of patients that experienced symptoms.²² (Diarrhea led to a discontinuation of the study in 6% of patients receiving the Glucophage monotherapy.)

Metformin does not cause hypoglycemia by itself, but when used in combination with other diabetic treatments, there is potential for hypoglycemia.²⁴ Hypoglycemia can be avoided by careful monitoring of blood glucose levels.

Gastrointestinal effects occur in up to 50% of patients using metformin. They include bloating, diarrhea, nausea, abdominal pain, flatulence, anorexia, and dyspepsia, but these symptoms are almost always transient and resolve within a few days, especially when metformin is taken with food or in a gradual titration.^{6,22} Common side effects can be seen in Table 1.

The major route of elimination of metformin is via the renal tubules, so any known compromised kidney function is a contraindication for the drug because it increases the risk of DKA. Metformin is also contraindicated in hypoxic conditions such as cardiovascular collapse, acute myocardial infarction, congestive heart failure that requires pharmacological treatment, and acute or chronic metabolic acidosis.¹¹ However, recent research has shown the positive effects of metformin on cardiovascular events, leading to an indication that it may be beneficial to use in patients with cardiovascular disease histories and may even help prevent cardiovascular events.^{3,22} Lastly, metformin is contraindicated in patients with severe liver dysfunction and severe chronic obstructive pulmonary disease because these disorders increase the acidic state of the patient, which could potentially lead to DKA.¹¹

Mechanism of Action

For a long time, metformin's mechanism of action (MOA) was unknown.^{4,6,27} Since the drug was first synthesized in 1922, it has taken almost 80 years to start comprehending the cellular and molecular mechanisms. Even though much more is now known about the multiple effects of metformin, the mechanisms of these pleiotropic effects are still ambiguous.

It is believed that, in counteracting hyperglycemia, metformin binds to the protein complex 1 in the respiratory complex chain. In Figure 5 this binding is visualized. To get to the protein complex 1 in the mitochondrial membrane, metformin must first be transported inside the cell via organic cation transporter 1 (OCT1).^{1,3} Metformin has a pKa of 12.4, so it is fully protonated and positively charged at physiologic pH; thus it does not passively diffuse through the cell.³ That is why OCT1 is so important in metformin's action, and deletion of the *Oct1* gene can cause metformin to be ineffective.

When metformin binds to protein complex 1 in the mitochondrial membrane it causes inhibition of the electron transport chain, which leads to decreased levels of cyclic adenosine monophosphate (cAMP) in the cell, which leads to decreased ATP production. This activates adenosine monophosphate kinase (AMPK), which leads to an increased activity in the ATP-generating pathways and decreased activity in ATP-consuming pathways to counteract the imbalance.³ By increasing and decreasing these pathways, metformin helps the patient regulate homeostatic levels, keeping circulating lipids, glucose, and insulin levels low. AMPK decreases glucose levels, ectopic fat deposition, insulin secretion, glucose production, lipid synthesis, lipolysis, and lipogenesis. Increased AMPK activity increases glucose uptake, lipid oxidation, mitochondrial biogenesis, and insulin sensitivity.³¹ The systemic effects of AMPK activation listed can be seen in Figure 6.

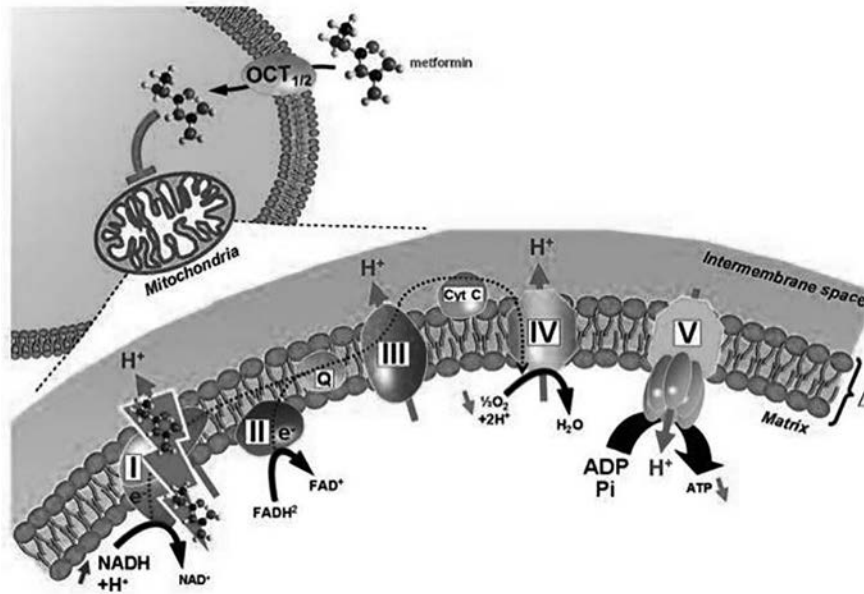


Figure 5. Metformin's mechanism of action in the respiratory chain complex.³

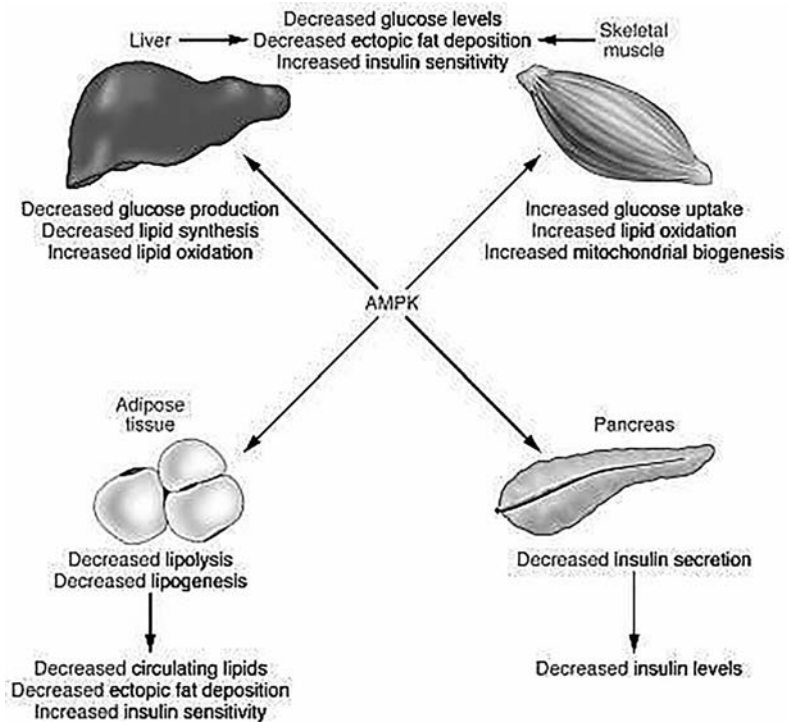


Figure 6. Systemic effects of metformin.³¹

Polycystic ovarian syndrome (PCOS) affects approximately 10 percent of women; it is an endocrinopathic condition in which cysts develop on the ovaries, leading to increased androgen production, insulin resistance, amenorrhea, and anovulation.⁴⁸ When administered to women with PCOS, metformin has been shown to increase ovulation, improve menstrual regularity, reduce serum androgen levels, and improve insulin sensitivity.⁴⁹ The exact molecular mechanisms of metformin in these effects remain elusive, but it is thought that they are a result of decreased insulin exposure in the ovaries.³ High levels of insulin in the ovary have been shown to increase activity of steroidogenic enzymes.⁵⁰

In clinical trials metformin has also been shown to reduce risk of abortion in women with PCOS, by increasing factors such as IGFBP-1 and glycodelin levels, as well as increasing uterine blood flow, which protect the developing embryo and fetus. Metformin also decreases factors such as endometrial androgen receptor expression, PAI-1, and plasmic ET-1, which at high levels increase risk for abortion.^{3,50} Again, the mechanisms that cause these effects are unknown, but the effects may be in part due to metformin's improvement of insulin sensitivity.³

Heart disease is a major threat to patients with T2D; in fact, it is the leading cause of death in those with T2D.^{9,51} But metformin can reduce diabetes-related death and all-cause mortality by 42 and 36 percent, respectively, as demonstrated in the longitudinal UK Prospective Diabetes Study (UKPDS), which followed approximately 1700 T2D patients for 10 years and was reported in 1998.⁵² The lower death rates among those administered metformin can be attributed to the AMPK activation and reduced amounts of ATP.

Forouzandeh and fellow researchers (2014) discovered the benefits of metformin in combating heart disease in mice and concluded that metformin attenuates atherosclerosis and vascular senescence in mice fed a high-fat diet and prevents the upregulation of angiotensin II type 1 receptor by a high-fat diet in the aortas of mice. Thus, considering the known deleterious effects of angiotensin II mediated by angiotensin II type 1 receptor, the vascular benefits of metformin may be mediated, at least in part, by angiotensin II type 1 receptor downregulation.⁴³

Pharmacokinetics

According to Bristol-Myers Squibb Company, Glucophage (metformin) has an absolute bioavailability under fasting conditions of 50 to 60 percent. Since metformin is usually taken with food, absorption is decreased and slightly delayed in regular usage, but the clinical relevance of metformin's potency decreasing with food is unknown. Maximum levels of concentration are achieved within a median value of 7 hours and a range of 4 to 8 hours. Interestingly, high-fat or low-fat meals made no differences in the maximum concentration of Glucophage.²²

Whereas sulfonylureas are 90% bound to plasma proteins, metformin is negligibly bound and partitions into erythrocytes as a function of time. The apparent volume of distribution averaged 654 ± 358 L in clinical trials. Steady state plasma concentrations are reached in 1 to 2 days.²²

Metformin is excreted unchanged in renal tubules and does not undergo hepatic metabolism or biliary excretion, as evidenced by the renal clearance of metformin being 3.5 times greater than creatinine clearance. After 24 hours, approximately 90 percent of metformin is eliminated via the renal tubules.²²

Future Directions

Metformin has been shown to reduce inflammatory markers in obese mice fed a high-fat diet. Kim's team (2013) discovered that several markers—including TNF-alpha, IL-6, leptin, resistin, tPAI-1, and MCP-1—were all significantly reduced in the obese mice when administered metformin, compared to control groups.⁵³ Since inflammatory markers are a part of the metabolic syndrome and are related to developing obesity, T2D, and cancer, more research is currently delving into utilizing metformin as an anti-cancer agent. Metformin's anti-cancer effect may be related to its antioxidant capabilities.⁵⁴

Onken and Driscoll (2010) discovered that metformin increased the lifespan of aging *Caenorhabditis elegans*, a dirt worm, by inducing a dietary restriction-like state:

We report that metformin extends *C. elegans* median lifespan via a mechanism that requires the cellular energy sensor AMPK, its upstream activating kinase LKB1, and the downstream DR/oxidative stress responsive transcription factor SKN-1, but is independent of the insulin signaling pathway components that modulate longevity. Our data on metformin outcomes are consistent with the interpretation that metformin acts, at least in part, as a dietary restriction mimetic in *C. elegans* and suggest that this activity is executed via a mechanism that is conserved from nematodes to humans. Implications of these findings could influence development of plausible anti-aging therapies based on a drug currently used in the clinic.⁵⁵

Martin-Montalvo and fellow researchers (2013) found metformin to increase the lifespan in mice by mimicking the bodily effects of calorie restriction, even though food intake was increased.⁵⁶ They suggest that an adaptation to metformin occurs, leading to reduced oxidative stress and increased antioxidant defenses, which contribute to lower oxidative damage accumulation and inhibition of chronic inflammation.⁵⁶

The UKPDS longitudinal study not only found a reduction in mortality due to heart disease, as stated earlier, but also found that metformin increases the longevity of life in high-risk diabetic patients as compared to sulfonylureas.⁵² To assess its anti-aging properties, metformin is currently being administered in a 6-year-long clinical trial, labeled the Targeting Aging with Metformin (TAME) study, with 3000 elderly people who meet certain high-risk characteristics.⁵⁷ Various websites and magazines have latched onto this study, and they tout the claim that metformin could increase the average expected lifespan to 120 years.^{57,58,59}

Developing Drugs

New drugs on the market to treat T2D include thiazolidinediones (TZDs), peroxisome proliferator-activated receptor gamma (PPAR γ)², meglitinides, and milk protein-based enzymes.

TZDs promote fatty acid uptake and storage in adipose tissue, according to the “fatty acid steal” hypothesis. They “increase adipose-tissue mass and spare other insulin-sensitive tissues such as skeletal muscle and the liver, and possibly pancreatic beta cells, from the harmful metabolic effects of high concentrations of free fatty acids. Thiazolidinediones thus keep fat where it belongs.”⁶⁰ With TZDs, adipose tissue expression and serum concentrations of adiponectin also increase. This effect, combined with the lowering of serum free fatty acid levels, contributes to increased hepatic insulin sensitivity, the lowering of hepatic fat content, and the inhibition of hepatic glucose production. Thus glucose concentrations in the blood decrease and serum insulin concentrations decrease as a consequence of enhanced insulin sensitivity and clearance.⁶⁰ The most serious contraindication of TZDs applies to patients with heart failure, because of the potential to cause heart failure due to salt/fluid retention.¹⁵ Also, first-generation TZDs caused serious liver damage in patients, but the newer generations are not as apt to cause such harm.

Meglitinides are similar to sulfonylureas in that they block potassium channels in the beta cell, but they also have the same hypoglycemic effects as sulfonylureas.¹⁹ The meglitinides have a rapid response in insulin secretion and a short half-life.⁶¹

The newest drugs, still being researched, are protein- and hormone-based enzymes, alpha-glucosidase inhibitors and dipeptidyl peptidase-IV (DPP-4). These are milk-protein-derived peptides found in fermented dairy or other foods containing bioactive peptides that may have positive impacts on bodily functions or conditions, and ultimately benefit overall health. They are currently the subject of intensive research.⁷

Alpha-glucosidase inhibitors inhibit the enzyme alpha-glucosidase, which digests carbohydrates, at the enteric brush-border.¹⁹ Use of these inhibitors results in an increase in overall carbohydrate digestion time, and less glucose is absorbed.^{62,63} DPP-4 is a multifunctional transmembrane protein that is widely distributed in different organs and tissues, including the exocrine pancreas, sweat glands, salivary glands, mammary glands, thymus, lymph nodes, intestines, biliary tract, kidney, liver, placenta, uterus, prostate, brain, blood cells, and integument. It is known for inactivating the incretin hormones GLP-1 and GIP via cleavage of peptide bonds after proline or alanine. Since GLP-1 and GIP are hormones that are released after eating and enhance up to 60% of the postprandial insulin release, inhibition of the DPP-4 enzyme allows GLP-1 and GIP to continue enhancing insulin release.⁷

The current evidence shows that alpha-glucosidases and DPP-4 can be found in whey protein isolates and, when administered in conjunction with a meal, T2D patients experienced improved insulin release. When administered in isolation, milk-derived peptides have been shown to have detrimental side effects.⁷ Researchers note that, as a consequence,

there is an increasing attention toward natural, safe, food-derived peptide inhibitors as these are without any side effects. Milk protein-derived peptides with alpha-glucosidase and DPP-IV inhibitory traits potentially regulate the postprandial hyperglycemia in healthy and T2D subjects by inhibiting both the inactivation of the incretin hormones and the carbohydrate hydrolyzing enzymes.⁷

Conclusions

Despite the wide array of options for treating T2D, metformin remains one of the best anti-diabetic drugs on the market because of its efficiency in lowering blood glucose levels in patients with T2D and its extremely low risk of side effects such as hypoglycemia and acidosis. Instead of compounding the issue by simply adding more insulin or stimulating more insulin secretion as other common diabetic agents do, metformin works with the body to regulate homeopathic processes. It is currently indicated to treat not only insulin-resistant diabetes such as T2D and gestational diabetes, but also polycystic ovary syndrome. The full pleiotropic effects of metformin may not yet be fully discovered, and it is currently being researched for anti-cancer and anti-aging treatments. Lastly, metformin is an affordable option due its simple synthesis and cost effectiveness.

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Artist's Statements

Tracey Raupp

Immeasurable Gold

Imagination and knowledge—one evolves into the other, always dependent on perspective. Both faculties, however, retain their value when all else is no more.

Content Cohesion

Structures are not always destructive of nature; when their design and construction respect the natural environment, human structures can offer another perspective.

Change of Movement

As the forms of nature advise us, movement cannot always proceed in a straight line. We have to know when to alter course in order to grow even when the challenges are invisible to others.

Immediacy

Toiling away, reaching to fulfill our desires and with a need for immediate gratification, we neglect to look at how the actions of others affect us and what toll we really face.

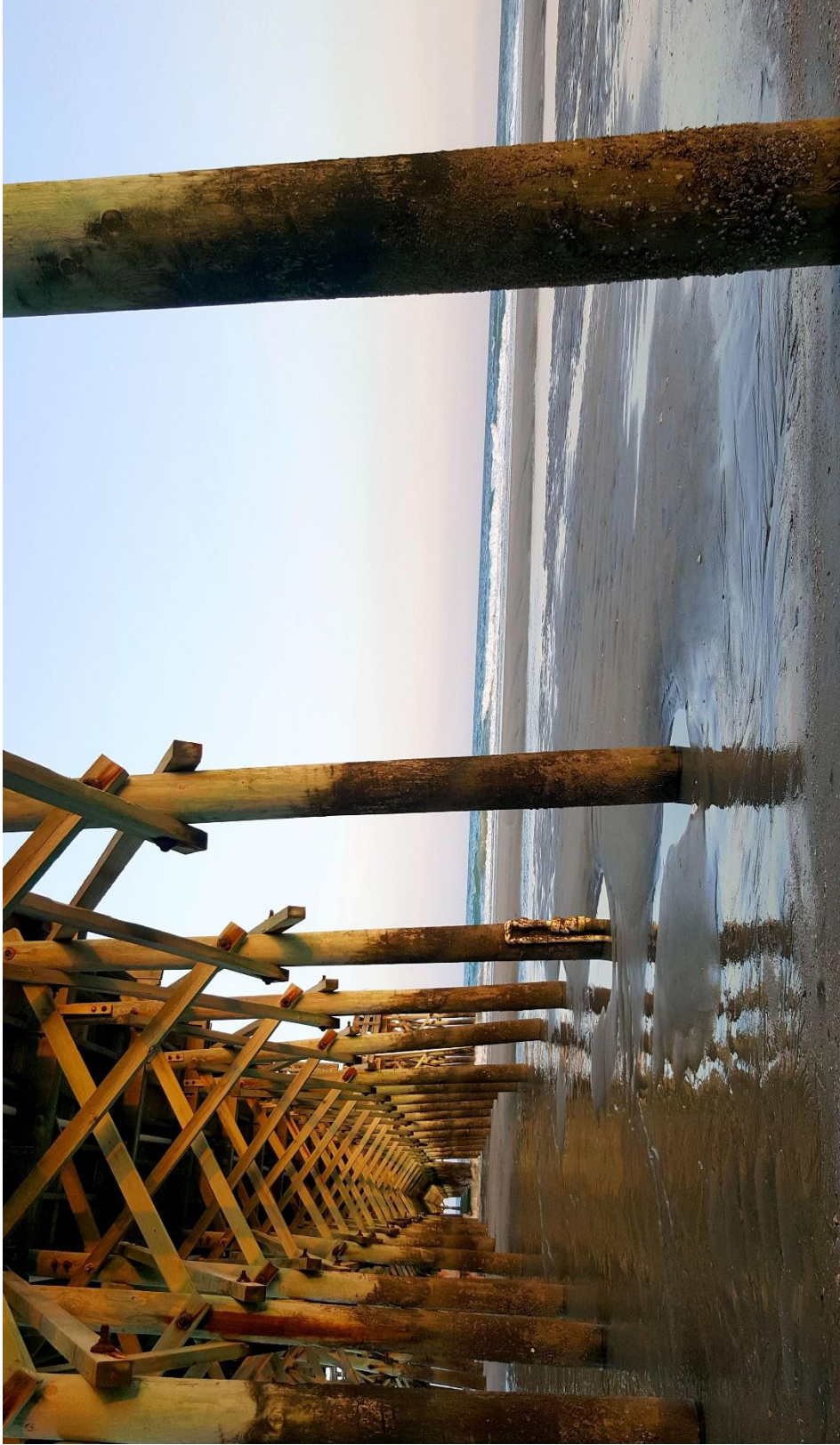
Innerworkings

When we take the time to experience what's really there, whether by looking more closely or by taking a step back, we discover an unexpected reality.



Immeasurable Gold

Tracey Raupp



Tracey Raupp

Content Cohesion

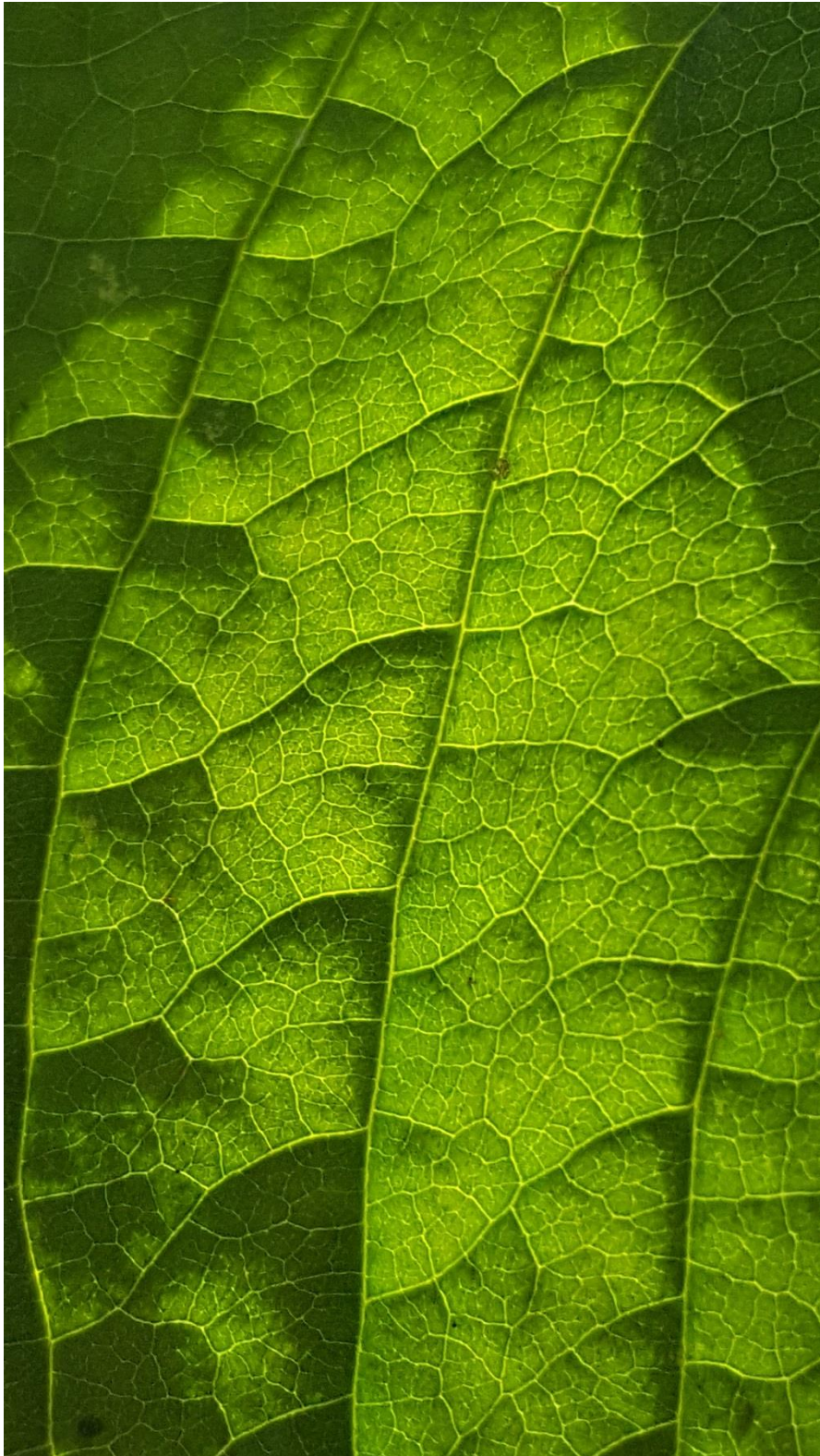


Change of Movement

Tracey Raupp



Tracey Raupp



Tracey Raupp

Innerworkings

Nutritional Requirements and Nursing Care Management for Diabetes Mellitus

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Abstract

Diabetes is a chronic disease that involves some variation of insulin secretion and insulin resistance problems. Thus, an understanding of the pathophysiology and nutritional requirements for those diagnosed with diabetes mellitus is vital for both the patient and the health-care provider. Nutritional modifications involving carbohydrate intake and portion size are at the center of diabetes management. The theoretical framework of Dorothea Orem's self-care model is applied to patient teaching and empowerment. Various tools recommended by the American Diabetes Association can increase patient adherence to an individualized nutrition plan.

Introduction

Diabetes mellitus is a disease that affects 29.1 million Americans and is the seventh leading cause of death in the United States (American Diabetes Association (ADA), 2016). There are 1.4 million Americans diagnosed with diabetes each year, and another 8.1 million who go undiagnosed (ADA, 2016). Diabetes is defined as a disease affecting the metabolic processes of blood glucose within the body (Pellico, 2013). Diabetes mellitus is divided into four categories: type 1, type 2, gestational, and a category of other that is comprised of glucose intolerances that share etiological similarities with diabetes. Diagnosis of types 1 and 2 is dependent on the pathophysiology and risk factors associated with each.

Diabetes is a debilitating disease that, if left untreated, can lead to secondary complications, comorbidities and death. Diabetes management includes an individualized diet that focuses on carbohydrate intake, coupled with insulin and/or oral medications (Lutz, Mauzur & Litch, 2015). Nurses play a key role the education and teaching of newly diagnosed diabetes patients. Applying Dorothea Orem's model of self-care to patient education will ensure that patients are capable of self-care with regard to the patient's medication regime, diet and exercise. With an understanding of the pathophysiology and nutritional requirements of individuals diagnosed with type 1 and 2 diabetes, and mindful of Orem's model, nurses and other health-care providers can intervene to facilitate patient adherence to meal plans.

Application of Theoretical Framework

Dorothea Orem's self-care and self-deficit theory as it relates to diabetes management relies on the assumption that people have the ability to care for themselves and the principle that nurses are responsible for identifying the deficient areas (O'Shaughnessy, 2014). Patients are recognized as distinct individuals who must be held accountable with respect to self-care. Nurses must first recognize whether a patient has the ability to provide self-care and then follow up with an assessment of the patient's readiness to learn and barriers to learning. The nurse is responsible for providing self-care measures when the patient is incapable of self-care (Felicilda, 2011). Dorothea Orem's theory recognizes the importance of educating patients on the complications and comorbidities associated with non-compliance with their diabetes management plans. Explanation of the physiology behind nutrition, specifically carbohydrates, increases patients' knowledge for self-care. Patients who remain non-compliant to self-care must be reassessed, and other methods of education and motivation should be applied.

Pathophysiology of Diabetes Mellitus

Diabetes is a chronic disease resulting from deficiencies in the secretion and/or action of insulin. Insulin is a hormone secreted by the beta cells of the pancreas, also referred to as the Islets of Langerhans. The pancreas manages blood glucose levels through the secretion of several hormones, including insulin, glucagon, somatostatin and pancreatic polypeptide (Pellico, 2013). Insulin transports blood glucose into various cells of the body, which can then metabolize the glucose and use it for energy (Pellico, 2013). Type 1 and type 2 diabetes have similar treatment methods; however, it is crucial for nurses as well as patients to understand the physiological differences between the two classifications of diabetes.

Type 1 diabetes is a chronic autoimmune disease that targets the beta cells of the pancreas (Ozougwi, Obimbo, Belonwu & Unakalamba, 2013, p. 48). It affects roughly 1.25 million Americans (ADA, 2016). The onset occurs early in life, and the disease is one of the most prevalent chronic diseases affecting children; however, cases have been reported later in life (Atkinson, Eisenbarth & Michaels, 2014). The exact cause is unknown, although researchers believe genetic predispositions, and immunologic and environmental factors play a role in the destruction of beta cells (Atkinson et al., 2014).

The destruction of pancreatic beta cells by autoantibodies contributes to a lack of insulin secretion, resulting in a state of hyperglycemia. Insulin is also responsible for inhibiting glycogenesis and gluconeogenesis, which, if left unchecked, can also contribute to hyperglycemia (Pellico, 2013). The absence of insulin in the bloodstream inhibits cellular uptake of glucose, resulting in the breakdown of adipose tissue for energy. The breakdown of fat and proteins results in a byproduct of ketones, which can eventually lead to a state of metabolic acidosis in the patient, also known as ketoacidosis, that may result in coma or death if not treated (Pellico, 2013). Diabetic ketoacidosis is a serious risk factor for type 1 diabetics due to the body's inability to produce insulin; it is rare in type 2 diabetics due to their ability to secrete minimal amounts of insulin (Pellico, 2013). The process of ketoacidosis can be avoided through proper nutritional education and medication adherence. Type 2 diabetes can present similar clinical scenarios; however, the

disease process differs from type 1 as it relates to patient comorbidities associated with the disease.

Type 2 diabetes affects 90% to 95% of the individuals diagnosed with diabetes (Pellico, 2013). Type 2 diabetes is primarily associated with the obese and aging populations; however, since the 1980s the obesity rate among United States children has tripled, leading to diagnosis of type 2 diabetes at an earlier age (Imperatore et al., 2012). The disease process results in decreased secretion of insulin by pancreatic beta cells, and cellular insulin resistance. This results in reduced cellular uptake of glucose from the bloodstream, coupled with ineffective glucose regulation by the liver (Pellico, 2013). Excessive glucose in the bloodstream leads to a state of hyperglycemia; however, there is still a small amount of insulin production, preventing or reducing the risk for diabetic ketoacidosis (Pellico, 2013). Type 2 diabetes can go undetected in patients and is usually diagnosed upon routine laboratory screenings. Although the pathophysiology differs between type 1 and type 2 diabetes, nursing care and patient education encompass the same nutritional education.

Nutritional Requirements for Diabetes Mellitus

Dietary requirements for a patient with diabetes mellitus are not unlike routine United States Department of Agriculture (USDA) recommendations. However, poor nutritional choices coupled with obesity are factors that contribute to type 2 diabetes. The amount of carbohydrate, fat, and proteins may be adjusted based on metabolic goals and individual preferences of the patient with diabetes (ADA, 2013). Nutritional changes are some of the most difficult to adopt, and some patients may never agree to make healthier food choices. The health-care provider can apply Dorothea Orem's self-care and self-deficit theory to determine a patient's ability to provide self-care.



Which Foods Can Help Control Blood Sugar Levels?, n.d., *Healthy Dining Finder*. <https://www.healthydiningfinder.com/getattachment/9aed58d5-7c0c-4676-8b7d/3bbd7f96187c/Which-Foods-Can-Help-Control-Blood-Sugar-Levels.aspx>

Nutritional management of diabetes focuses on the patient's food choices, portion sizes, and consumption of carbohydrates. The most effective tools used to facilitate patient education include MyPlate for Diabetes, Dietary Guidelines for Americans, and the USDA Food Guide (Lutz et al., 2015). The ADA recommends that patients use the USDA's Food Exchange List in conjunction with MyPlate for Diabetes to facilitate meal planning. (See Appendix A for examples of each food group.) The USDA's Food Exchange List is a tool that is comprised of six food groups broken down by nutrients and serving size (Lutz et al., 2015).

Patients with diabetes benefit from choosing a variety of foods high in fiber, such as fruits, whole grains and vegetables. These foods provide vitamins, minerals, and complex carbohydrates that do not lead to a spike in blood glucose (Lutz et al., 2015). Nutritional goals and lifestyle modifications for patients with diabetes include attaining and maintaining blood glucose levels within normal limits through the adequate intake of food, endogenous and exogenous insulin, and physical activity (Lutz et al., 2015). Meal planning should be individualized to each patient and include healthy foods choices the patient is willing to eat.

Meal Plan

Nurses and health-care professionals can apply Orem's theory of self-care to diabetic nutritional teaching. The patients are at the center of their own care and must take responsibility for the management of their disease. The nurse can educate the patient on healthy food choices and portions using the ADA guidelines. Applying Orem's theoretical framework to the teaching, the patient can then give the nurse an example of a meal plan for one day that he or she can adhere to, and that also falls under the recommended guidelines set forth by the ADA. (See Appendix B for an example of a diabetic meal plan.) Research suggests that collaborating with the patient to strengthen motivation and movement toward therapeutic goals increases the success rate of healthy diabetes management (Sherman, 2016).

Conclusion

Diabetes is a chronic debilitating disease that, if left untreated, can lead to secondary complications including death. Application of Dorothea Orem's self-care and self-deficit theory places the patient at the center of his or her own treatment plan, not the health-care provider. Treatment of diabetes begins with proper education in regard to nutrition and medication regimes. The management of diabetes centers on the patient as his or her own change agent. Patients must have a willingness to learn and change unhealthy behaviors regarding food choices in order for management to be successful. Health-care providers should educate patients on the different types of diabetes and which type they are diagnosed with, as the pathophysiology of type 1 diabetes differs from that of type 2 diabetes in regard to insulin secretion and resistance. Understanding how the disease process affects the body helps patients understand why food choices are important to diabetes management. Tools like MyPlate for Diabetes, the Food Exchange List, and the USDA Food Guide can facilitate the transition to a more healthful diet.

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Appendix A. One Serving of Carbohydrates (CHO) by Food Group

Food Group	Grams of CHO	Example of one serving
Starch	15 grams	1/3 cup cooked pasta or rice
Non-starchy vegetables	5 grams	1 cup raw vegetables (broccoli)
Fruits	15 grams	1 small fresh fruit (apple)
Free foods (<3 servings)	0 grams	Condiments (1tbsp catsup)
>3 servings	5 grams	
Protein	0 grams	1 oz. cooked beef, chicken
Sweets, Desserts, and other carbohydrates	15 grams	Desserts, sweets (1 tbsp. regular syrup, 2 small cookies)
Fats	0 grams	1 tsp. margarine, butter
Milk and Milk substitutes	12 grams	1 cup fat free (skim) milk or low-fat (1%) milk
Combination foods and fast foods	15 grams	1 cup of tomato soup

Appendix B. Sample Meal Plan for a Diabetic Patient Maintaining Weight

Breakfast	Snack	Lunch	Dinner	Snack
2 hard-boiled eggs 1 slice whole wheat toast 1/4 avocado 1/2 cup 100% fruit juice (unsweetened)	1/2 cup cooked carrots 1 small apple 1 oz. string cheese	Large green salad with chicken (11.5 oz.). 2 tbsp. fat free dressing 1 small roll	6 oz. pork tenderloin 1 cup cooked brown rice 1/2 cup cooked broccoli	1/4 cup cottage cheese 1 1/4 cup strawberries 1/2 banana
30g CHO	20g CHO	30g CHO	30g CHO	25g CHO

Engaging and Supporting Fathers with Breastfeeding Partners

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Abstract

Health-care professionals need to address fathers' concerns regarding engagement with and supportiveness of breastfeeding partners. Fathers often feel left out during the mother's perinatal care and do not get the same amount of education and support, especially with respect to breastfeeding. A common complaint among fathers is the lack of practical information specifically related to the paternal figure. Educational classes involving child care and breastfeeding information provide positive results, with an increase in breastfeeding rates. Albert Bandura's Social Cognitive Theory relates the theoretical aspect with the practical aspect in providing useful interventions to facilitate support. The purpose of this inquiry is to address the need to adopt interventions that engage and assist fathers with supporting their partners. However, there is still a lack of research regarding effective interventions that assist fathers and increase breastfeeding duration.

Introduction

Breastmilk is the ideal nutrition for newborns and infants. It provides all the necessary nutrients for health development and contains important antibodies that help protect the infant from common childhood illnesses (World Health Organization, 2016). Beyond the immediate benefits for children, breastfeeding contributes to positive long-term health outcomes. Adolescents and adults that were breastfeed are less likely to become overweight or obese, or to develop type II diabetes (World Health Organization, 2016). Not only is breastfeeding beneficial to infants, it also reduces the risk of breast cancer, ovarian cancer, type II diabetes, and postpartum depression in mothers (World Health Organization, 2016).

Improving the well-being of mothers, infants, and children is an imperative public health goal for the United States. To serve this goal, the *Healthy People 2020* report developed target goals to increase the proportion of infants who are breastfed at six months to 60.6%, and to increase the proportion of infants who are breastfed at 12 months to 34.1% (U.S. Department of Health and Human Services, 2016). According to the Centers for Disease Control and Prevention (CDC) *Breastfeeding Report Card*,

breastfeeding rates are gradually rising; however, breastfeeding duration is not meeting the recommended goals (CDC, 2014). Organizations continue to establish interventions to promote and encourage women to breastfeed, but consistently fail to implement interventions to support fathers.

Research suggests that paternal involvement during the antenatal and postpartum periods significantly improves the mother's success with breastfeeding. Several studies provide evidence that mothers are more likely to successfully breastfeed if the baby's father is involved in breastfeeding initiation and support (Brown & Davies, 2014; Fisher, 2013; Hunter & Cattelona, 2014; Nickerson, Sykes & Fung, 2012; Özlüses & Çelebioglu, 2014; Raesi, Shariat, Nayeri, Raji & Dalili, 2014; Sherriff, Hall & Panton,



One-Hundred-Days Baby and Dad, 24 August 2016, by miapowterr. Creative Commons (free, no attribution). <https://pixabay.com/en/one-hundred-days-baby-dad-1616112/>

2014; Sherriff, Panton & Hall, 2014). Hunter and colleagues revealed that more mothers with supportive partners were exclusively breastfeeding at six months than those who had no involvement and support from the infant's father during the early postpartum period (Hunter & Cattelona, 2014). Nickerson and colleagues also discovered that mothers wanted their infants' fathers to be involved in the decision to breastfeed, as well as to provide support throughout the course of breastfeeding (Nickerson et al., 2012). The interviewed women also suggested that fathers would benefit greatly from more peer and professional support, lactation services, and breastfeeding education (Nickerson et al.,

2012). However, health-care professionals remain largely uninvolved in measures to successfully prepare the paternal figure for breastfeeding support.

The Paternal Experience

Fathers genuinely want to be involved and support their partners in the breastfeeding process. Many fathers have expressed their eagerness to learn more about specific health benefits of breastfeeding and ways in which they can support their partners (Brown & Davies, 2014; Datta, Graham, & Wellings, 2012; Fisher, 2013; Sherriff & Hall, 2011; Sherriff et al., 2014a, 2014b). Despite these positive attitudes, fathers frequently feel helpless and guilty that they are unable to assist their partner with feeding or to overcome issues involving feeding (Brown & Davies, 2014, Datta et al., 2012). Some fathers even express feelings of isolation from the mother and infant, as well as concerns regarding the opportunity to develop a relationship with the infant (Mitchell-Box & Brown, 2012; Sherriff & Hall, 2011). However, fathers report that health-care professionals disregard their opinions and feelings, and explicitly educate the mother (Sherriff & Hall, 2011). When fathers were interviewed regarding perinatal care, they reported a lack of attendance because of conflicts related to work schedules (Sherriff et al., 2011). Making appointments and classes that are available for working partners is imperative for the father to develop a sustainable relationship with the unborn child and become educated about breastfeeding and child care. Some fathers voiced that they wanted to be included in the information that was delivered to their partner so that they could be competent in assisting the mother with decisions and care (Brown et al., 2014; Sherriff et al., 2014a, 2014b). Perinatal visits usually address the mother and the child, disregarding the father's questions or concerns. Oftentimes, fathers are overlooked by health professionals and not addressed in perinatal visits. Thus, educating health professionals about the importance of engaging fathers during perinatal visits and being appropriately responsive to father's questions can provide a positive learning environment in which fathers do not feel embarrassed or threatened.

Practical Interventions

Informational Materials

Literature and/or services provided to fathers should avoid using the term "parent" and explicitly use "father" so that marketing is directed or relevant to them (Sherriff et al., 2011). Jarold Johnston, a certified nurse midwife and lactation consultant, and a major in the U.S. Army Reserve, wrote a section called "Dads and Breastfeeding" in *Breastfeeding in Combat Boots: A Survival Guide to Successful Breastfeeding While Serving in the Military* by Robyn Roche-Paull, that addresses common concerns and issues that fathers face during breastfeeding (Johnston in Roche-Paull, 2010). Johnston provides practical information that fathers eagerly seek. First, he addresses common signs that signal the infant is ready to eat and reassures the father that newborns eat 8 to 12 times a day in clusters of 3 to 4 times in a 4-hour period (Johnston, 2010). He provides guidance on how to assist the mother with latching and how to recognize the observable signs of a "good latch," which include the following: the infant's nose and chin touch the breast,

the infant's cheeks are round without dimples, the infant's chin is opened wide, the mother experiences no pain, and the infant's lips are flared both up and down (Johnston, 2010).

Having served in the military, Johnston worked with patients who were military service members and their families. To educate the father on how to solve latch issues, he applied the acronym "SPORTS," which is identical to the acronym for the corrective action used for the M-16 rifle that is taught during military basic training ("Slap, Pull, Observe, Release, Tap, Shoot") (Johnston, 2010). This military training device can easily be adapted to the breast feeding situation: "Support the back. Pull the chin. Observe for change. Release the chin. Try again. Shoot! We need to take him off and try again" (Johnston, 2010). Information that is similarly tailored for specific populations of fathers is essential for practical guidance and support. Despite the fact that literature continues to cite the need for practical information, studies fail to evaluate the effectiveness of informational tools such as pamphlets versus books, or posters versus flyers, and so on.

Educational Classes

Child care training sessions or classes for fathers and prospective fathers have also resulted in higher rates of breastfeeding, but more research is needed to evaluate the effectiveness of classes and different types of lesson plans (Sherriff et al., 2011). Researchers Wolfberg and colleagues compared breastfeeding rates for fathers who attended two different classes; the experimental group attended a class that discussed infant care and breastfeeding while the control group only discussed infant care (Wolfberg et al., 2004). These classes were held every two weeks, were two hours long, and consisted of small groups of about four to twelve fathers (Wolfberg et al., 2004). Both classes were led by the same peer-educator, were interactive and informal, and used media and discussion to facilitate group interactions (Wolfberg et al., 2004).

In the experimental group, videos demonstrated technical aspects of breastfeeding and ways to support the partner during feeding (Wolfberg et al., 2004). The purpose of the experimental group was to educate fathers how to advocate on behalf of breastfeeding and how to work effectively with their partners to make breastfeeding successful (Wolfberg et al., 2004). Beliefs and values were tested regarding breastfeeding, and fathers were allowed to express their concerns and talk about misconceptions (Wolfberg et al., 2004).

Mothers were surveyed eight weeks postpartum; successful breastfeeding initiation was reported by 74% of mothers whose partners had attended the experimental class, compared to initiation by only 41% of mothers whose partners attended the control class (Wolfberg et al., 2004). This study indicates the value of interventions to educate and support fathers to promote breastfeeding. Nonetheless, the study had limitations regarding sample size and demographic variables (Wolfberg et al., 2004). Further research is needed to observe the impact of innovative educational programs for fathers and the effect these programs have on breastfeeding duration.

Theory-Based Interventions

Breastfeeding education is frequently centered around the "breastfeeding dyad" (mother-infant relationship), but recent studies are revealing the need to shift focus

towards the “breastfeeding triad” (mother-infant-father relationship) (Mitchell-Box & Braun, 2012). This shift recognizes the importance of the father figure in supporting and strengthening breastfeeding efforts. Researchers Mitchell-Box and Braun (2012) explored fathers’ knowledge and attitudes about breastfeeding, and suggested interventions based on Albert Bandura’s Social-Cognitive Theory (see Bandura, 2001). The Social-Cognitive Theory proposes that individuals learn from a social context with a dynamic and reciprocal interaction among the person, environment, and behavior (Bandura, 2001). It places emphasis on external and internal social reinforcement. The interventions used by Mitchell-Box and colleagues were separated into three themes: making the decision, making it work, and third wheel for feeling left out (Mitchell-Box & Braun, 2012).

The first theme, “making the decision,” involves providing paternal-focused educational pamphlets and contact information for peer support groups (Mitchell-Box & Braun, 2012). Reinforcing practical information and providing guidance to the father figure prior to pregnancy or during early stages of pregnancy can facilitate the couple’s decision to breastfeed. Just as mothers need to be informed, fathers need to understand why breastfeeding is beneficial and how they can support their partners through it. Health professionals strongly influence this decision-making process, resulting in need to educate health professionals about the importance of fathers and interventions to engage fathers.

The second theme, “making it work,” is based on the self-efficacy theory (Mitchell-Box & Braun, 2012). Self-efficacy refers to an individual’s belief in his or her capacity to implement behaviors necessary to produce specific performance outcomes (Bandura, 1977, 1997; Bandura & Cervone, 1983). It reflects the individual’s ability to confidently exert control over his or her own motivation, behavior, and social environment (American Psychological Association, 2016). Bandura’s self-efficacy theory addresses self-motivation and proposes that those who have a low sense of self-efficacy are typically discouraged by failure, whereas those who are confident in their goal attainment abilities will continue to strive for success even when efforts fail (Bandura, 1977, 1997). The father’s self-efficacy is important to consider when addressing breastfeeding issues. Poor performance or lack of performance may occur if fathers are not confident in their ability to assist their partners. Health-care professionals can provide fathers with the tools necessary to promote self-efficacy through continuous and early education (Bandura & Cervone, 1983; Mitchell-Box & Braun, 2012). Educational topics include the health of breastfeeding benefit, differences compared to formula, proper positioning of the infant, recognition of signs that the infant is hungry or full, and resources for guidance (Mitchell-Box & Braun, 2012).

The last theme is “third wheel for feeling left out,” which focuses on observational learning and expectations established in peer support groups (Mitchell-Box & Braun, 2012). Fathers often express concerns or feelings of being left out or lacking the opportunity to develop a relationship with the infant (Sherriff & Hall, 2011). Therefore, Mitchell-Box & Braun (2012) suggest that support groups allow fathers to share negative feelings and discuss advantages, challenges, and overall experiences with breastfeeding. Studies report that peer support groups can be effective at educating and supporting individuals; however, more research is needed to address whether males are positively influenced by peer support (Layzer, Rosapep, & Barr, 2014; Piette, Resnicow Choi & Heisler, 2013).

Conclusion

Although numerous studies provide evidence that the father's support increases the mother's likelihood of breastfeeding, evidence remains scant on how to engage and support fathers in breastfeeding situations. Mothers have reported that their infants' fathers were a significant factor when deciding to breastfeed as well as in continuing to breastfeed. Fathers have openly expressed their willingness to learn more about breastfeeding but are consistently overlooked by health-care professionals even when they attend perinatal care with their partners.

Educating health-care professionals about the importance of engaging fathers during perinatal visits is an important intervention to empower fathers with self-efficacy. Practical information that is "father approved" and targeted specifically toward fathers was a common request among the various studies. Fathers want to be provided with information that is useful and addresses their questions regarding how to assist their partners through difficult times. More evidence is needed to validate the effectiveness of peer support groups, classroom instruction, and educational materials such as books, pamphlets, and posters. Therefore, further studies should be conducted to determine the most effective ways that health-care professionals can support fathers and provide valuable educational information.

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Analysis of Factors Contributing to Poverty in the United States: An Empirical Study

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Abstract

This research seeks to answer the question “What social and economic factors correlate to high or low poverty rates?” through an analysis of quantitative and qualitative studies. This empirical study was conducted using data on the 50 states in the United States. The dependent variable, poverty, was correlated with seven independent social and economic variables, namely education, divorce, female-headed household, crime, welfare, unemployment, and minimum wage.

This study finds significant data in support of and contrary to previous literature. The major findings were that the strongest correlation existed between female-headed households and poverty rate, and between unemployment and poverty rate. It also finds that minimum wage and government spending on welfare had no correlation with poverty rates.

As state governments and policy makers pursue their agendas, these findings may be useful in identifying factors that need further attention and policies that need to be restructured in the fight to eradicate poverty.

Introduction

Poverty is an issue that affects different aspects of the American society ranging from social to economic facets. Over the past decades, poverty—coupled with recessions, increased inflation and high unemployment—has reduced the standard of living of many Americans. The fight against poverty is embedded in recent American history and has evolved over the decades to incorporate various policies—such as Medicaid, Social Security, and housing subsidies—aimed at eliminating poverty. While the federal government and state governments, through actions such as the federal welfare reform of 1996, have been trying to create strategic policies that would more effectively target the segments of the population that need help, it can be argued that poverty remains a threat to the economic growth and social stability of the American society.

According to a report by the Center for American Progress (2015), “in 2014 more than one in seven Americans—46.7 million people—lived below the official federal poverty level of less than \$24,000 per year for a family of four” (1). This striking statistic indicates the ongoing poverty struggle that many families are facing. An individual is

considered poor if his or her total family pretax income in a given year is below the poverty threshold for the family size and age composition. By definition, all persons in the same family have the same poverty status. The segment of the population considered poor and living below the poverty line is faced with challenges that make daily life a struggle. The adversities that result from poverty permeate through different aspects of an individual's life and affect their overall well-being.

Given the seriousness of poverty and its adverse effects, this research project addresses the following question: "What social and economic factors correlate to high or low poverty rates?" Using quantitative and qualitative data from all 50 states in the United States, made available in the MicroCase database (LeRoy 2013), the researcher analyzed the correlation of the dependent variable, poverty, with seven independent social and economic variables: education, divorce, female-headed household, crime, welfare, unemployment, and minimum wage. The incidence of female-headed households and the unemployment rate were found to most strongly correlate to poverty rates, while high minimum wage and high government spending on welfare—which might be expected to affect poverty rates—were found not to coincide with low poverty rates.

Literature Review

Poverty has become one of the broader indicators by which the welfare and the standard of living of some nations are measured. In the United States (US), the Census Bureau officially measures poverty by determining the number of persons or households living below an established level of income that is estimated to be minimally sufficient to support them. The federal government, working with state governments, continues to strive toward helping individuals and families living in poverty by providing services and income transfers through various programs and welfare reform initiatives. Creating these programs means considering factors that contribute to the prevalence of poverty. It is crucial to analyze and understand these factors.

This literature review discusses four schools of thought concerning the origins of poverty, in order to provide insight into the various factors contributing to the prevalence of poverty. The purpose of this section is to survey the existing literature about various causes of poverty. Four influences will be examined: welfare programs, family structure, economic factors, and structural factors.

Welfare Programs

The aggregate-level relationship between welfare benefits and poverty rates is of interest to establish the overall impact of public assistance on poverty rates. Murray (1984) argues that increases in the generosity of welfare programs with the "War on Poverty" initiated an opposite effect by increasing the poverty rates. He claims that welfare alternatives to work make people less eager to work towards securing employment and that criminal activity offers another economic choice for people (Murray 1984).

Fording and Berry (2007) conducted analysis of data from the states and empirical tests highlighting the effect of welfare programs as a work disincentive. Their

results were consistent with critics of welfare programs such as Murray (1984). They found that

the ability of an increase in welfare benefits to reduce the poverty rate declines as three variables decrease: (i) the size of the initial cash benefit in relation to the poverty threshold; (ii) the relative share of the benefit increment that is provided via cash, as opposed to in-kind, assistance; and (iii) the wage level earned by unskilled workers. (Fording and Berry 2007, 55)

Family Structure

Significant changes in family structure and living arrangements over the past years have arguably affected poverty rates. Mangum, Mangum and Sum (2003) assert that the relatively high American poverty rate is because of the increasing proportion of single-parent families. These researchers claim that family size and family structure impact poverty across the board. Data reflects that family poverty problems have become more concentrated over time among families with children and families headed by women. According to researchers, “Married-couple families consistently have the lowest rate of poverty with statistics showing a 4.7 % rate as opposed to 11.5 % among male householders with no spouse present to a high of 24.7 % among female householders with no husband present for the year 2000” (Mangum, Mangum and Sum 2003, 59).

Some highlighted characteristics that make female-headed families more poverty-prone include the limited potential for earned income, as in most cases these families tend to be headed by young females with less work experience and lower commensurate earnings potential. This point is highlighted by Iceland (2013), who states that female-headed families are more likely to be poor because women who are the sole heads of their households face the challenge of supporting a family on a single income and often must pay for child care while they work. Sugrue (1994) argues that unmarried and divorced mothers encounter discrimination in the labor market; this is reflected by the fact that, on average, women earn only 66 % of the amount men earn, an inequality that is probably greater among poorly educated and untrained female workers.

The family structure school of thought is also supported by Rodgers and Rodgers (1993), and their analysis of cross-section data reflects how the intensity of the poverty of female-headed households is more pronounced than annual poverty measures show. The poorest group identified by this researchers contained people living in families headed by African-American females without high-school diplomas, for whom chronic poverty was reported to be about twelve times as intense as in the overall population (Rodgers and Rodgers, 1993).

Economic Factors

According to Iceland (2013), economic processes affect trends in poverty in two ways; these include the view that economic growth determines the absolute increases and reductions in the average standard of living of individuals, and the proposition that economic inequality affects the distribution of income. Mangum, Mangun and Sum (2003) state that the relatively high American poverty rates result from a less-equal income distribution, low earnings for the underprepared, and a less-generous income support system. In this view, the lack of improvement in poverty rates despite rising

living conditions is due to the stagnation in growth of median wages and increasing inequality (Hoynes, Page, and Stevens 2006).

Additionally, “the poverty rate is extremely sensitive to the level of unemployment, which has trended upward in recent years[. Another critical variable is inequality (the variance as opposed to the mean of earned incomes), and the increase in earnings inequality over the past few decades has worked to raise the incidence of poverty even when growth or other factors were operating to reduce it” (Sawhill 1988, 1092).

Structural Factors

Supporters of the structural school of thought maintain that most poverty has structural roots that often foster economic and social barriers for different groups: discrimination grounded in racial or gender identification form the most threatening obstructions.

Abramovitz (1996) argues that the disproportionately high rate of poverty among women could be viewed as the result of a patriarchal society that continues to resist their inclusion in a part of society that has been primarily dominated by men, and consequently welfare programs have been structured in ways that condemn public support for women as distinct from marital support; both arrangements tend to reinforce patriarchy. As a result, the rise in poverty among women is an important structural variable to analyze.

Conclusion

To position the research on the prevalence of poverty, four schools of thought have been described. Essentially all aspects—effect of welfare programs, economic inequality, structural factors, and family structure—contribute in different ways and at the same time they are inter-linked. The research literature that has been developed by different researchers sheds light on the underlying causes of poverty and the various ways poverty is exacerbated.

In the next section, the methodology and the variables that correlate to existing theories and research will be described, and hypotheses defined.

Methodology

This section of the paper concentrates on the operationalization of the research topic in addition to defining the variables that contribute to the prevalence of poverty. The literature review highlights various scholars and schools of thought that have attempted to provide insight into the various factors contributing to poverty in the different states. The research question “What social and economic factors correlate to high or low poverty rates?” will be examined by identifying independent and dependent variables, and hypothesizing the correlation between these variables. The independent variables selected are expected to convey the economic and social factors that contribute toward and cause poverty. The States file from MicroCase software (LeRoy 2013) will be used to retrieve data for this study.

Concepts and Variables

This research paper will use variable number 704) POVERTY04, sourced from the States file, in order to operationally define the dependent variable, which is poverty. The variable description states that it reflects “percent of population in poverty” in 2004. According to Hoynes, Page and Stevens (2006), “In 2004, the poverty threshold for a family of four was roughly \$19,000, and for a single individual it was approximately \$10,000.” (49).

The independent variables that will be treated as contributing to the prevalence of poverty include education, divorce, female-headed household, crime, welfare spending, unemployment, and minimum wage. In the following paragraphs, these variables will be conceptually defined.

Social Variables.

1. Government spending on education (955 ED\$PC 02)—This is a ratio variable that indicates the per capita state and local government expenditures for education for the year 2002. The range of this variable is from 1546 to 3287.
2. Female-headed households (287 FEM.HEAD 00)—This is a ratio that indicates the percent of households that are female-headed with no spouse present for the year 2000. The range is from 8.23 to 17.72.
3. Violent crime rate (1211 VCRIMES 04)—This is a ratio variable that indicates the number of violent crimes per 100,000 population.
4. Divorce rate (255 DIVORCE 04)—This is a ratio variable which indicates the number of divorces per 1000 population for the year 2004. This data is sourced from the National Center for Health Statistics. The range is from 2.20 to 6.40.

Economic Variables.

5. Unemployment rate (812 UNEMP05)—This ratio variable indicates the unemployment rate. The data is obtained from the US Bureau of Labor Statistics. The range is from 2.7 to 9.9.
6. Minimum wage (811 MIN_WAGE 06)—This is a ratio variable that indicates the minimum wage in dollars. The range is from 2.65 to 7.63.
7. Welfare spending (709 WELF_SL\$)—This a ratio variable that indicates the per capita state and local spending on welfare programs for the year 2002. The range is from 517.00 to 1697.00.

Hypotheses—Social Variables

Social factors identified by researchers and theorists are framed in a set of hypotheses.

Hypothesis 1. There is a negative relationship between education spending and poverty.

States that spend on their education system would arguably be more likely to produce a workforce that is skilled and knowledgeable. This will place people in a better position to attain employment, thereby providing them with a source of income that eliminates poverty.

Hypothesis 2. There is a positive relationship between the percent of female-headed households and poverty.

In comparison to households headed by men or families where both parents are present, female-headed households have a higher risk of poverty due to unequal access to sufficient economic resources necessary for their survival. This inequality of access could come in the form of unequal earnings in comparison to men and/or discrimination faced by unmarried and divorced women with respect to employment opportunities in the labor market.

Hypothesis 3. There is a positive relationship between the violent crime rate and poverty.

Crime inhibits the development of the society and economy on a micro and a macro level. It creates a vicious cycle that promotes instability and reinforces and exacerbates poverty. The presence of crime discourages economic activity and social development in those areas where crime is prominent.

Hypothesis 4. There is a positive relationship between divorce and poverty.

Generally, it is assumed that marriage is, in part, an economic union; therefore, marital dissolution leads to the loss of two incomes in most cases. Divorce could be seen as a cause for poverty primarily due to the loss of income and decrease in standard of living that results.

Hypotheses—Economic Variables

Economic factors identified by researchers and theorists are framed in a set of hypotheses.

Hypothesis 5. There is a positive relationship between unemployment and poverty.

An unemployed individual has no means to earn or generate income, which increases the risk of poverty for the individual and his or her dependents. Unemployment restricts access to market income, quality education, adequate medical facilities, and means to facilitate the creation or acquisition of income-earning assets. These conditions often lead to indebtedness and create a poverty cycle that is generational.

Hypothesis 6. There is a negative relationship between the minimum wage and poverty.

Increasing the minimum wage would arguably generate positive results in the fight against poverty and efforts to grow the middle class, thereby boosting incomes and reducing the number of people living in poverty.

Hypothesis 7. There is a positive relationship between spending on welfare and poverty.

Increased targeting of benefits can create disincentive structures that exacerbate poverty. As previously stated in the literature review section, welfare alternatives to work make people less eager to work or take responsibility for their own conditions.

Research Method

This proceeds with an empirical analysis that utilizes secondary quantitative data to address the research question. The States file in the MicroCase software is based on public records and aggregate data on the 50 states of the US; it contains 1748 variables. Among these variables, this study will utilize 8 variables for analysis. Guidelines are sourced from the *Research Methods in Political Science: An Introduction Using MicroCase*, 8th edition (LeRoy 2013).

This study will be using scatter plots and ANOVA to determine if there is any relationship between the independent variables and the dependent variable. In analyzing the data further, a test of statistical significance will be conducted. Statistical significance measures whether the hypothesized relationship between the variables in a sample obtained from a population exists *as a product of chance* in the population from which the sample was extracted. The measure of statistical significance is identified as “prob” and the acceptable cut-off point is 0.05. It is generally accepted that when the statistical significance is below this point, then the relationship is statistically significant. However, if the “prob” is greater than the numerical value 0.05, the relationship is deemed statistically insignificant, because it means there is greater than 5% probability the results occurred by chance.

Measures of association will be used to determine the strength of relationship between the two variables being analyzed. For the purposes of this study, two measures of association will be used: Pearson’s Correlation Coefficient (r) for scatterplots and Eta Squared for ANOVA. The following scale will be used to determine the strength of the relationship for r :

- If r is less than 0.25, the relationship is too weak to be useful.
- If r is between 0.25 and 0.34, the relationship between the variables is weak.
- If r is between 0.35 and 0.39, there is moderate strength of relationship between the variables.
- If r is 0.40 and above, there is a strong relationship between the variables.

The strength of the relationship for Eta Squared ranges on the following scale:

- If the value of Eta Squared is less than 0.10, the relationship is too weak.
- If the value of Eta Squared is between 0.10 and 0.19, the relationship is weak.
- If the value of Eta Squared is between 0.20 and 0.29, the relationship is moderate.
- If the value of Eta Squared is above 0.30, the relationship is strong.

Essentially, this methodology will help in determining the factors that contribute to the high prevalence of poverty in some states as opposed to others. The next section, Findings and Analysis, will present and explain the research findings.

Findings and Analysis

ANOVA and scatterplot regressions, derived from the MicroCase (2013) software, test all seven hypotheses. This section presents an explanation and analysis of these statistical measures as applied to the hypotheses..

Social Variables

Hypothesis 1—Education Spending and Poverty. The first hypothesis states that there is a negative relationship between education spending and poverty. In Figure 1, the scatterplot shows the relationship between the dependent and independent variables. Poverty rate, the dependent variable, is presented along the y-axis and the independent variable, education spending, is presented along the x-axis.

The regression line indicates a negative relationship between the two variables. The “prob” value was 0.0002, which is below 0.05; this means that the relationship between education spending and poverty rates is statistically significant. The Pearson correlation coefficient is -0.399, which means that there is a negative, moderate-strength relationship between the two variables.

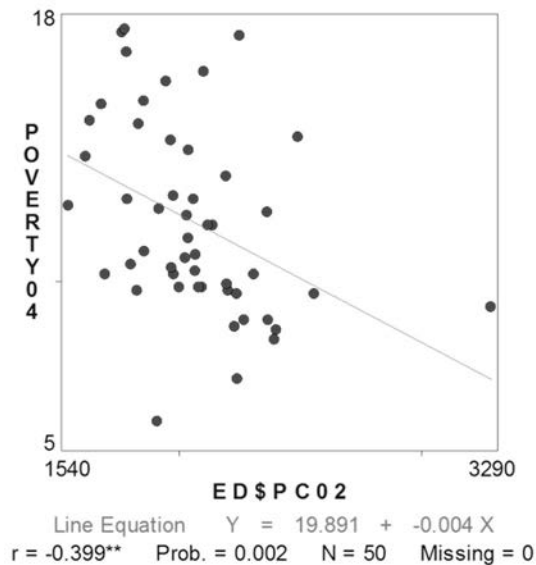


Figure 1. Poverty by education spending.

This value is reflective of the fact that education equips individuals with the necessary skills and knowledge for attaining better-paying jobs. States' spending on education contributes to an increase in incomes, and this translates into reduced poverty rates. Education spending is an investment that significantly lifts people in the long run. Furthermore, “among individuals living in families in which the head has less than a high school education, 31.3 % are below the poverty line, compared with just 9.6 % of those whose head has at least a high school education” (Hoynes, Page, and Stevens 2006, 3).

Hypothesis 2—The Percent of Female-headed Households and Poverty. The second hypothesis states proposes a positive relationship between the percent of female-headed households and poverty. The scatterplot in Figure 2 shows the relationship between these two variables where the dependent variable, poverty, is along the along the y-axis and the independent variable, percent of female-headed households, is along the x-axis. The probability of this relationship not occurring in real life is 0.000, which makes it statistically significant. The Pearson coefficient is 0.519, meaning there is a positive, strong relationship between these variables. The hypothesis is supported.

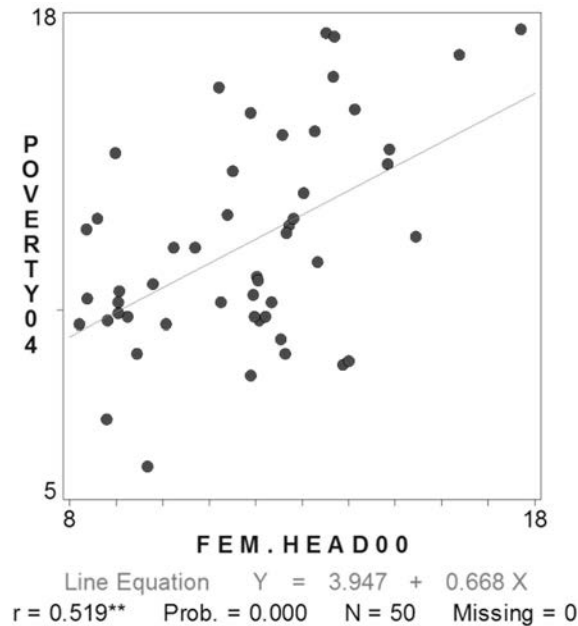


Figure 2. Poverty by female-headed households.

Female-headed households are more vulnerable to poverty in comparison to male-headed households. Single mothers who are not working and do not have access to welfare tend to face multiple barriers to work, including low education, health problems, and/or a history of domestic violence or substance abuse. Women, especially unmarried or divorced women, face discrimination in the workforce, and female sole heads of household rely on a single income source that is often insufficient for supporting them and their dependents. They also earn considerably less than their male counterparts. Louisiana has a significantly high level of female-headed households at 16.40, and its poverty rate is equally high at 17. Minnesota has a low poverty rate (7.00) and the rate of female-headed households is also low, at 8.81.

Hypothesis 3—Violent Crime Rate and Poverty. The third hypothesis posits a positive relationship between the violent crime rate and poverty. Crime inhibits development of the society both in social and economic aspects; therefore, poverty is reinforced. Figure 3 shows the scatterplot regression between violent crime rates and poverty. This scatterplot has poverty, the dependent variable, along the y-axis, and violent crime rate, the

independent variable, along the x-axis. The probability reflected from this test is 0.005, making it statistically significant. The Pearson Correlation Coefficient is 0.364; this value suggests a moderate positive relationship between the two variables. The hypothesis is supported.

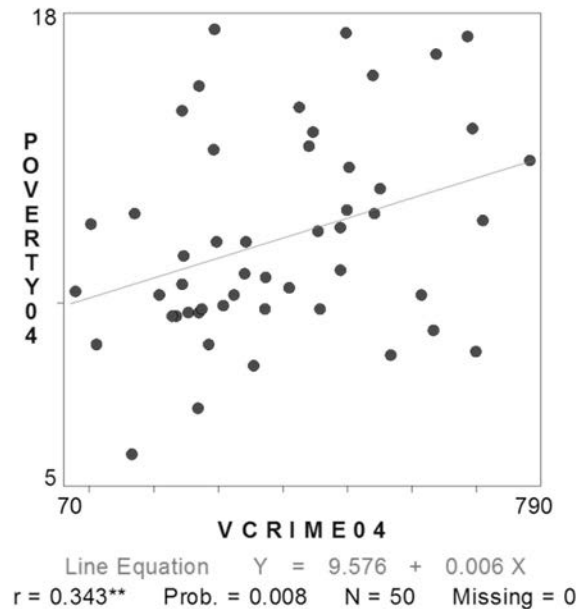


Figure 3. Poverty by violent crimes.

Violent crime fosters instability in society and limits individuals as well as businesses, creating an atmosphere and platform for poverty to thrive. Violent criminal acts against people and businesses debilitate the core components that help societies prosper. Businesses are less likely to establish themselves in neighborhoods that experience violent crimes, and this affects the economic opportunities for the inhabitants. People’s standards of living are compromised.

Hypothesis 4—Divorce and Poverty. The last hypothesis of the social variables states that there is a positive relationship between divorce and poverty. The scatterplot in Figure 5 shows the two variables being tested. Along the y-axis is the dependent variable, poverty, and along the x-axis is the independent variable, divorce.

The probability value for this relationship is 0.004, which makes this hypothesis statistically significant. The Pearson correlation coefficient is 0.395, reflecting a positive, moderate relationship between these two variables. Mississippi and North Carolina have high divorce rates and high poverty rates, which makes the case for correlation between the variables. Further supporting this correlation, New Hampshire has low divorce rates as well as the lowest poverty level out of all 45 cases utilized in the data.

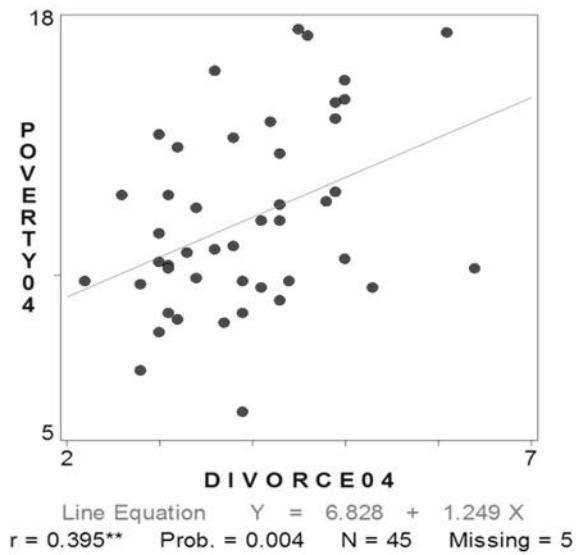


Figure 4. Poverty by divorce.

Economic Variables

Hypothesis 5—Unemployment and Poverty. The first hypothesis concerning economic variables states that there is a positive relationship between unemployment and poverty.

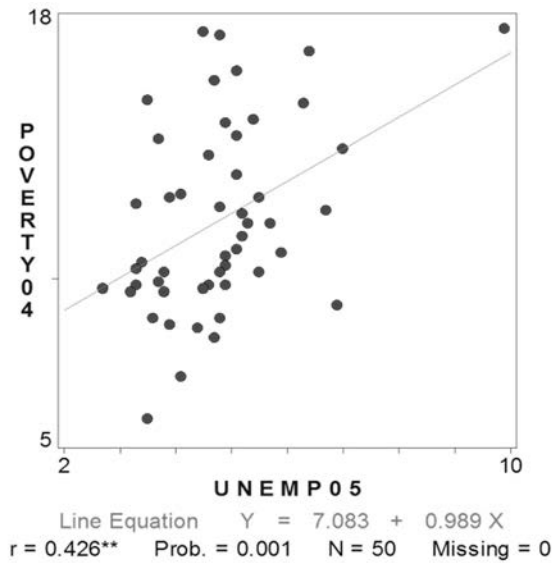


Figure 5. Poverty by unemployment rate.

On the scatterplot in Figure 6 along the x-axis is the independent variable, rate of unemployment, and along the y-axis is the dependent variable, poverty.

The probability value for this result is 0.001, which means that this relationship is statistically significant. The Pearson correlation coefficient is 0.426, indicating a positive, strong relationship between unemployment and poverty. This hypothesis is supported.

High unemployment limits people's access to market income, and thus to quality education, adequate medical facilities and the means to facilitate the creation or acquisition of income-earning assets.

Hypothesis 6—The Minimum Wage and Poverty. The second economic hypothesis states that there is a negative relationship between the minimum wage and poverty: the expectation is that the higher the minimum wage, the lower the poverty rates. Figure 7 shows the scatterplot of these two variables, the y-axis showing the dependent variable (poverty) and the x-axis showing the independent variable (minimum wage).

The probability value reflected by the result is 0.195; therefore, this relationship is not statistically insignificant. The Pearson correlation coefficient value is 0.134, indicating that the relationship between the amount of minimum wage and poverty is too weak to be meaningful. Therefore, this hypothesis is not supported.

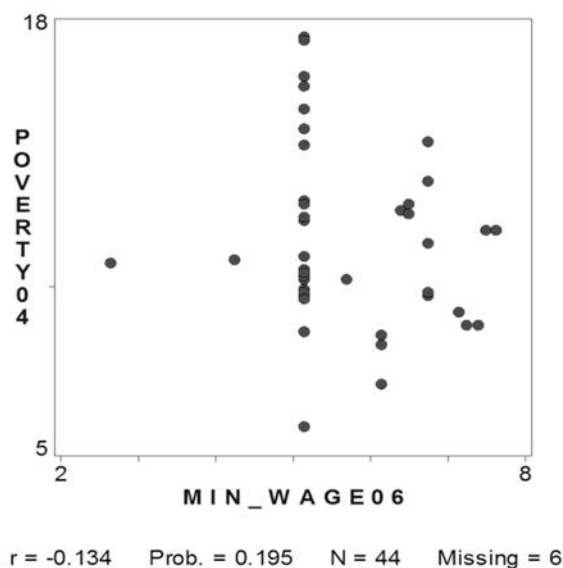


Figure 6. Poverty by minimum wage.

This result is interesting because increased minimum wages boost income levels, which could translate into lower poverty rates and a better standard of living. However, the data in this research suggests that there is no correlation between the amount of the minimum wage and poverty.

Hypothesis 7—Welfare Spending and Poverty. The third economic hypothesis in this section, and the final one of this study, proposes a positive relationship between welfare. The results give a probability value of 0.28, rendering this result statistically insignificant.

Furthermore, the Pearson correlation coefficient is 0.065, which is below 0.25; this means that the relationship between the two variables is too weak to be useful.

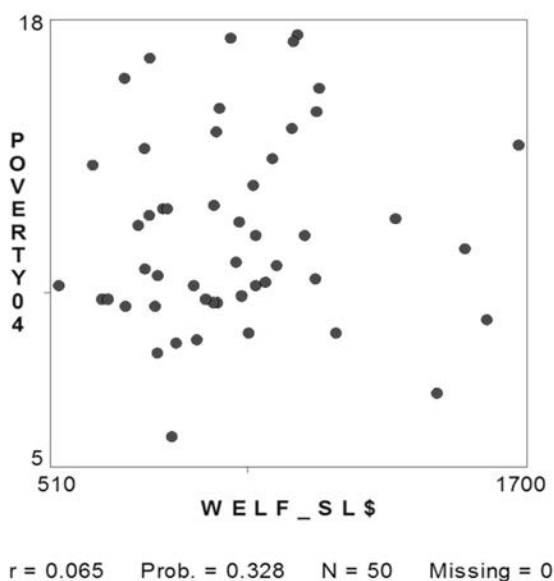


Figure 7. Poverty by welfare spending.

This result is interesting, especially as some scholars highlighted in the literature review state that welfare spending reinforces and worsens poverty. For example, some researchers argued that “[w]elfare programs such as Aid to Families with Dependent Children (AFDC) benefits failed to empower single mothers and their children to survive, let alone achieve financial independence [while also] providing a disincentive for people to work and encouraged idleness” (Fording and Berry 2007). Nonetheless, the data indicates this was not the case: welfare spending did not worsen poverty.

Conclusion

This study was aimed at providing better understanding of the underlying contributory causes of poverty at the states’ level. Two main categories were explored, namely social and economic variables. In order to analyze the issue of poverty and the factors contributing to its prevalence, this project utilized quantitative studies. An empirical study was conducted using data on the 50 states in the US from the States file in the statistical package provided by LeRoy (2013).

Poverty continues to be a burden on American society, making it a constantly relevant subject of study. The economic and social progress of the US is destabilized by poverty. Both individuals and families living below the poverty line continue to face daily struggles and challenges that affect their well-being and standard of living. This problem also extends to the younger generations, thereby reinforcing a vicious poverty cycle over the long run.

The hypotheses and findings are grouped into two categories of independent variables, economic factors and social factors, that may contribute to the persistence of poverty. Within the social category were four variables, namely education spending, divorce rate, female-headed household and violent crimes. This study found that the strongest correlation was between the incidence of female-headed households and the poverty rate of states. Unmarried and divorced mothers, like women generally, face discrimination in the labor market, exclusion, and high income inequality, rendering them less able to generate the means to live above the poverty threshold. They essentially have to rely on a single income source that is often insufficient to support them and their dependents. Furthermore, states that invested in education had a lower poverty rate. This correlation was expected because education equips individuals with the necessary skills and knowledge for attaining better-paying jobs; therefore, more generous state spending on education increases the likelihood that people live above the poverty threshold, thereby reducing poverty rates.

Furthermore, states that had a high rate of violent crime also had a high poverty rate; violent crime fosters instability in society and limits individuals as well as businesses. Violent crimes promote an environment that is not conducive for business to thrive, thereby eliminating economic opportunities for individuals in those neighborhoods to maintain a decent standard of living.

Within the economic category, the main variables analyzed were unemployment rate, welfare spending and minimum wage. The strongest correlation showed that states with high unemployment also had high poverty rates. Unemployment affects the economy on both a macro and a micro level as it limits individual's access to market income and hinders economic growth. On the other hand, the welfare spending and minimum wage hypotheses were unsupported by the findings. Although the literature review cited some scholars who argued that welfare programs aimed at benefiting single mothers and children failed to empower them and served as a disincentive towards achieving financial independence, there was no significant relationship between a state's welfare spending and its poverty rate.

Minimum wage as a variable under the economic factors category was also insignificant. This is interesting primarily because minimum wage as an economic factor is interpreted as capable of influencing the poverty levels. In general, it is expected that an increased minimum wage boosts income levels, which could translate into lower poverty rates and a better standard of living. The findings of this study did not support this view.

The issue of poverty should be addressed by state governments because it significantly decreases people's standard of living. The growth of the state's economy depends to an extent on the workforce, which is the human capital. Poverty hinders the development and progress of individuals and diminishes their productivity levels, making them unable to effectively contribute toward the growth of society and the economy. Therefore, state governments should invest more in human capital programs to increase productivity and earning capabilities of the people through education, including vocational training initiatives. In addition, violent crimes can be addressed through projects that address financial limitations that can steer individuals toward criminal conduct out of frustration and as a means of survival.

It is crucial that state governments address market conditions and policies that are discriminatory towards single, divorced or unmarried mothers. It is important that these women not be marginalized when it comes to equal income and access to employment opportunities. Given the fact that children born into poverty are less likely to break free from the cycle, it is imperative that women be empowered to maintain their families and their dependents above the poverty threshold. It is also important that the minimum wage be addressed to incorporate some form of increase. This is key especially in helping low-skilled individuals in low-wage paying jobs maintain an income stream that could help them escape poverty and in the long-run keep them above the poverty threshold.

State governments should invest more in human capital programs to increase productivity and earning capabilities of people through targeted educational and vocational training initiatives in public schools and community colleges. States must also address market conditions and policies that are discriminatory towards women. Furthermore, through implementing sustainable work supports, states could minimize gaps between what working poor families can earn in the low-wage labor market and what they need to meet their basic requirements. Work supports include any publicly-provided resource that either boosts the earnings of low-income workers or helps counterbalance the cost of a family budget component, including subsidies for health care, child care, housing, and transportation. These supports play an important role in helping to close the needs gap.

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About Our Contributors

Chioma Austin-Mona Azih

Originally from Nigeria but raised in Mbabane, Swaziland, Chioma Azih graduated *cum laude* from Methodist University in May of 2017 as she double majored in Political Science (with a concentration on International Relations) and Financial Economics, and minored in Business Administration. In 2017, she was a co-awarded the Political Science Outstanding Graduate Award. While at MU, Azih served in various leadership roles, including treasurer for the Model United Nations Club and vice president of finance for the Collegiate Entrepreneurship Organization. Additionally, she was inducted into the National Political Science Honor Society and Eta Sigma International Business Honor Society. Currently, Azih works as project manager for a business development consultancy in London. She plans to attain a Master of Science in International Development, as she is actively seeking to build a career in the field of research on socio-economic policies in developing countries.

Walter Barnett

Exposed to visual art as a child and inspired by his grandfather, Walter Barnett found his passion for art at an early age, though he rebelled against being told “how to draw” in high school art classes. Barnett majored in Graphic Design at Methodist and minored in Marketing while also pursuing athletic achievements and leadership training. At MU, he was awarded the 2016 Jazz Festival Outstanding Graphic Design Award and the 2016 Anthony J. DeLays Art Achievement Award, became a member of the National Society of Leadership and Success, was named in multiple USA South Athletic Conference All-Academic Teams and the USA South Athletic Conference All-Sportsmanship Team, and received the 2017 Men’s Soccer Steve Little Award. Since graduating, Barnett has done graphic design work on a freelance basis, collaborating with individuals, including award-winning actors and writers, and providing design services for groups that produce live entertainment events nationwide. He intends to continue his quest to establish himself as a successful graphic designer.

Courtney DeGarmo

Courtney DeGarmo graduated from Methodist University in May of 2017 with a bachelor’s degree in Nursing. From Palmdale, California, deGarmo spent ten years in the army before attending MU. Currently she works at Cape Fear Valley Hospital in the Intensive Care Unit. She plans to further her career by applying to a Doctorate of Nursing program that specializes in pediatric acute care. The topic of her research paper—nutrition in diabetes care—arose from a clinical rotation at the local Veterans Administration Hospital, where she had the opportunity to educate diabetic patients on their food choices. The experience brought home to her how vital good nutrition is to prevent and relieve not only diabetes but a wide array of common chronic diseases, and she now believes that nutrition education should be a national public health priority.

ABOUT OUR CONTRIBUTORS

Stephanie Dewell

From Corona, California, Stephanie Dewell obtained a bachelor's degree in Biology from Methodist University, graduating in December 2016. At Methodist she received an equipment grant from the Center for Research and Creativity. Dewell earned a place on the President's list and the Dean's list, and was a member of the chemistry honors society as well as the biology honors society. Currently she is applying to the North Carolina State College of Veterinary Medicine for the Doctor of Veterinary Medicine program. She aspires to obtain a DVM degree and work as a veterinary medical officer for the United States Army. Her field research into the clinical ailments of sloth species in Central and South America motivated her to write the research paper that appears in the *Monarch Review*.

Nina Derek

Nina Derek earned her B.A. in English from Methodist University in 2017. A member of honor societies Sigma Tau Delta and Chi Delta Chi, she graduated *magna cum laude* and received the Robert S. Christian English Award. During her undergraduate career, Derek enjoyed working as a student writing consultant in the Writing Center and as a staff member for the *Monarch Review*. Her writing appears in MU's *Tapstry* and in *Atlantis*, a creative literary magazine. After completing an internship with Longleaf Press, Derek decided to pursue a career in publishing. At present, she works as an editorial assistant for a publisher in her native state of Minnesota.

Emily Ewin

Emily Ewin graduated from Methodist University in May of 2017 with a bachelor's degree in Special Education. During her time at Methodist University, she was a captain of the women's lacrosse team, vice president of the National Residence Hall Honorary (NRHH), vice president of the Student Athletic Advisory Committee (SAAC), and a head resident assistant. While studying Special Education at MU, she was intrigued by the different types of teaching licensure and decided to find out how licensure correlated to student success, specifically in special education. This interest led her to write the paper that appears in this volume. Originally from Frederick, Maryland, Ewin began teaching special education in Salisbury, Maryland, following graduation from MU.

About Our Contributors

Matthew J. French

From Raleigh, North Carolina, Matthew French graduated from Methodist University in May of 2017 with a bachelor's degree in Biology and a minor in Chemistry. At Methodist he was inducted into Tri-Beta and Omicron Delta Kappa, and took part in the men's tennis team and the MU Chorale. He was motivated to write his research paper when he heard about the Wesley Heritage Research Project while leading men's Bible study. Currently, he works in Burlington, North Carolina, for LabCorp as a molecular microbiology laboratory technician, a step towards his goal of earning the necessary advanced degrees and becoming lead researcher at a genetics laboratory.

Jyoti Ghule

Jyoti Ghule, from India, came to Methodist University on a full scholarship from the United World College program. She will graduate in 2020 with a major in Sports Management and a minor in Accounting. In future Ghule plans to be a sports director or manager in her homeland and to help improve the sports industry there.

Katlin Harris

A native of Fayetteville, North Carolina, Katlin Harris graduated *summa cum laude* from Methodist in May of 2017, with a Bachelor of Music in Flute Performance and a minor in History. Presently, Harris continues her educational endeavors by attending Louisiana State University to obtain a Master of Music in Musicology. This is the third time Harris's performance on the flute has been featured in the *Monarch Review*. Her desire to learn more about the translation of Franz Schubert's compositional style between vocal and instrumental genres inspired her to craft the essay appearing in this volume. The topic of Schubert and his music continues to be a focus of her research.

Amber LeRoy

Amber LeRoy graduated from the University of Mount Olive in 2014 with a bachelor's degree in Biology and in May of 2017 from Methodist University with a Bachelor of Science in Nursing. She is from Radford, Virginia, but currently resides in Italy with her husband, who is in the military. LeRoy is employed with the Women, Infant, and Children (WIC) office and volunteers with the local Red Cross, health clinic, and United Service Organizations (USO) in her free time. Her career goal is to become more involved with women and children's health by furthering her education as a midwife. LeRoy's interest in women and children's health led her to write her paper about supporting and engaging fathers with breastfeeding partners.

ABOUT OUR CONTRIBUTORS

Christopher Miller

Christopher Miller plans to graduate in May of 2018 with a bachelor's degree in Biology. He is a native North Carolinian. During his Methodist University career, Miller served as secretary of the Lector Club, was inducted into the Phi Kappa Phi honor society, presented his "War for the Roses" essay during the Honors Program Panel at Methodist's 6th Annual Undergraduate and Research Symposium, and had his "Lessons from the Lorax" essay published in Phi Theta Kappa's 2015 edition of *Nota Bene*. After graduation, Miller plans to continue writing and pursue a career that will allow him to apply his knowledge of, and adoration for, plant life. The essay published in this volume is a product of his experience in Dr. Richard Walsh's course *Myth and Culture*.

Cheri Molter

Cheri Molter graduated *summa cum laude* from Methodist University in May 2017 with a B.A. in English, History, and Writing. She was awarded the Lucius Stacy Weaver Award for overall excellence and recognized with membership in several honor societies. In addition to her position as the student editor of both the 2016 and 2017 *Tapestry*, MU's journal of creative writing, Molter was the senior student editor of the *Monarch Review* in the academic year 2016-2017. Her writing has appeared in both the *Monarch Review* and *Tapestry*, and she has had a scholarly research paper published in *Aletheia: The Alpha Chi Journal of Undergraduate Scholarship* and poetry in the 2016 and 2017 editions of *Kakalak*. Recently, Molter landed a position with the fledgling North Carolina Civil War History Center, soon to break ground in Fayetteville, North Carolina, where she is tracing local descendants of African-American men from Cumberland County who helped form a Union regiment in the latter months of the Civil War. Molter is happily married, with one son and two daughters, and plans to pursue a Master of Library Science at East Carolina University.

Pooja Nikalje

An international student from Pune, India, Pooja Nikalje was fortunate to complete her high school education abroad, with two years at the international United World College of the Adriatic in Italy. While studying there, Nikalje won a full scholarship to study at Methodist University. Now a junior, she pursues a double major in Business Administration and Marketing. Being a woman and coming from a male-dominated country, she has found her journey challenging but feels the challenges have made her a strong independent woman.

ABOUT OUR CONTRIBUTORS

Tracey Raupp

Tracey Raupp double-majored in Business Administration and Management while also obtaining a double minor in Marketing and Organizational Communication & Leadership, and an Associate's degree in Leadership & Management. She graduated from Methodist University in December 2016. She was included on the Dean's list and was the MU Leadership Fellows Program Distinguished Graduate, and she was inducted into the Omicron Delta Kappa (National Leadership Society), Chi Delta Chi (Veterans Honor Society), NSLS (National Society of Leadership & Success) and the North Carolina E.A. Morris Leadership Fellowship (Class of 2017). With a diverse range of interests from cosmogony/astronomy to cognitive science, Raupp desires a career in the aerospace industry and plans to eventually start her own company. She is in the process of writing two books and compiling two books of photography for future publication. Raupp's photographic work has been published in every volume of the *Monarch Review* since its inception in 2013-2014. *Immeasurable Gold* is her first photo to be featured on the cover of the journal.

Stacey Marie Summers

Stacy Marie Summers's life changed last year, her second year at Methodist University: Skills suddenly began to blossom, her confidence rose, and she leaped into a prismatic world and a terrifying and exhilarating new life. Before that jump, Summers had entered MU in 2015 as a Graphic Design major. Despite the fantastic Graphic Design program offered at Methodist, she quickly fell in love with studio art, and it wasn't long before she changed her major to studio art, with a concentration in painting. She found the perfect complement to this major in creative writing, which became her minor. Both have significantly skewed her perception of what life is supposed to be. As her goals became more grand, she realized she needed to go a place that offered a better art market and moved back to Atlanta, a place where she had a "tribe" and major support. Now Stacy works daily in her studio creating art and struggling to become established as an artist. In Atlanta, where she is known simply as Stacey Marie, she has art work displayed at Relapse Theater, a popular comedy club in the downtown area, as well as at the Highlander in midtown, and has requests to hang work elsewhere.

Vrushali Thombare

Coming from a small village in India, Vrushali Thombare completed the high-school program (through 10th grade) at one of the few schools near her home. She then obtained a scholarship to study at the United World College—Dilijan in Armenia, completed two years of study there, and applied to several colleges in the United States. She chose Methodist University because of the high-quality education available at Methodist. Thombare is currently double majoring in English and Political Science. She plans to develop a career as an English teacher back in India.

ABOUT OUR CONTRIBUTORS

Dipali Tikone

Born in a small town in the Pune district of Maharashtra, India, Dipali Tikone was by parents who devoted their lives to farming. She completed the 10th grade in the only school in her town. Then her life took an unexpected turn with the opportunity to study abroad as one of only four people in her region selected in 2012 to attend United World College. Tikone completed her college prep courses at the UWC of Southern Africa in Swaziland and entered Methodist University in the fall of 2015. Currently a junior, she is pursuing a double major in Business Administration and Marketing.

Gabrielle Wentling

Gabrielle Wentling, from Fredericksburg, Pennsylvania, graduated *cum laude* in May of 2017 from Methodist University, where she studied Kinesiology with a concentration in Chemistry. While attending MU, she was a member of Sigma Alpha Pi, the president of Omicron Delta Kappa, and a U.S.A South Scholar Athlete during the Spring of 2013, 2014, and 2015. Wentling plans to attend medical school to become a physician and hopes to have her own practice in the United States and abroad. Her purpose in researching the drug Metformin was to gain a greater comprehension of both the pharmacological industry and the insulin-resistant aspect of the diabetic disease process.

Christopher West

Originally from Queens, New York, Christopher West graduated from Methodist University in 2016 with a Bachelor of Science in Chemistry with concentration in Biochemistry. West is recipient of the Clark Memorial Science Service Award. He is currently pursuing a Ph.D. in Analytical Chemistry at Purdue University, and some of his current research projects focus on the characterization and identification of secondary organic aerosols via Ion-mobility Mass Spectrometry. West hopes to work in a national laboratory in the U.S. with the Department of Defense, Pacific Northwest National Laboratory, or Environmental Protection Agency. In researching his paper on gingerol, he advanced his project to develop and optimize a means of synthesizing a useful form of the therapeutic component of ginger; the use of computational chemistry methods, as described in the paper, will help researchers optimize the molecules of interest in the gas phase of the synthesis process.

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- **Music recitals** may not exceed 7 minutes and can be submitted in .mp3, .mp4, .wmv, or .WAV format.
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- Submit all works electronically in doc or .docx form.
- Works must conform to the standard style of your paper's discipline (MLA, APA, Chicago, etc).
- Works must be fewer than 6,000 words and be in 12-pt Times New Roman or 11-pt Calibri font.
- Figures, charts, graphs or pictures must be submitted in .jpg format **in a separate file**. All images will be printed in black and white, so take care that they are still legible and informative without color. Clearly indicate where to insert each figure in the body of your text.
 - Ex: This sample text shows how to indicate where a figure goes in your paper (Insert FIGURE ONE).
- It is highly recommended that you have a consultation with a writing consultant at the Writing Center prior to submission.
- Students concerned about dual publication are advised to submit a research news report in lieu of a complete research paper.
- Research papers written for English composition classes generally do not meet the journal's standards and are not eligible for submission without prior authorization from the senior student editor or the coordinator.

Questions? Contact Managing Editor Baylor Hicks at sbhicks@methodist.edu or 910.630.7264 (Writing Center).