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## **explorations** The texas a&m undergraduate journal Fall 2015 | Volume VII

## Welcome to the seventh volume of *Explorations*: The Texas A&M Undergraduate Journal

Many of our readers may be unfamiliar with the opening of Texas A&M's mission statement:

#### "Texas A&M University is dedicated to the discovery, development, communication, and application of knowledge in a wide range of academic and professional fields."

Anybody perusing *Explorations* can see that undergraduate students are fully engaged in this mission. The articles in this issue represent just a sampling of the remarkable things undergraduate students are achieving at Texas A&M.

In my role as Associate Director for Undergraduate Research I have had the privilege of working with students from across campus as they experience the excitement of discovery. Many express their feeling that undergraduate research was the highlight of their Texas A&M career, providing them with unique knowledge, earned self-confidence, and a supportive network of faculty and graduate student colleagues who will positively impact their future. **Obviously, this message is spreading.** 

In just the past four years the number of undergraduate presentations at our Student Research Week has doubled to three hundred (exceeding the number of graduate competitors for the last two years) whereas the number of participants in our flagship thesis program, the Undergraduate Research Scholars, has quadrupled to over two hundred and fifty. *Explorations* provides a student-organized and edited outlet for these students to share their knowledge and enthusiasm with the Texas A&M community.

Congratulations to this year's Board, a dedicated group of student leaders who have worked hard to bring together this excellent issue. Thanks as well to the capable oversight of our faculty advisory board and particularly Annabelle Aymond, who enjoyed editing *Explorations* so much as a student she has joined our LAUNCH staff to shepherd future issues. Most importantly, *Explorations* would not be a success without the commitment of the faculty who mentor our undergraduate researchers. By documenting the productive interactions of undergraduate students and faculty, *Explorations* bears impressive witness to the successful achievement of our educational mission.



Duncan S. MacKenzie, Ph.D. Associate Director for Undergraduate Research, LAUNCH Associate Professor, Biology Texas A&M University

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## **Annie Salinas**

July 2014: This past summer, I found myself a thousand miles from home, working in a city where I knew almost no one. On a whim, I ordered a book from Amazon to read during my free evenings: Poems and Prose of Gerard Manley Hopkins. Every day I got off work at 5:00 p.m. and would go back to my apartment, grab a bottle of sweet tea and my book of poetry, walk to a nearby meadow, and watch the sun go down as I read. I discovered that reading Hopkins aloud was a delightful experience: his words tasted sweet, filled my mouth, danced over my tongue, and caught my breath. (The fireflies and cicadas got many poetic recitations.) Hopkins's lines, even just strings of words he used, became stuck in my head like lyrics to a pop song, begging repetition throughout the next day.

What made his poems sound so good aloud? The way the words fit together seemed so right. What made them stick in my head like a radio single, I wondered?

Later that summer, I had the opportunity to explore these questions. Upon returning to College Station, I began a summer research fellowship with Dr. Larry Mitchell in the Cushing Library. Since Dr. Mitchell is a philologist, I thought him the perfect person to ask about Hopkins. He encouraged me to explore these questions with my research. What I discovered over the next few months was a common thread—a golden echo—that resounds from the earliest literature of our language into the songs we sing today.

#### **Old English: The Echo Begins**

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"Old English" refers to the language spoken by the Anglo-Saxon people on the island of Britain before the Norman invasion of 1066. The Anglo-Saxons had a thriving tradition of poetry, much of which is probably lost because writing and literacy did not reach the British Isles until long after mainland Europe. The Old English tradition of story, song, and poem was oral. As is

Gerard Manley Hopkins, and the Lyrics That Stick in Our Heads gather in wooden halls, pass around mead-horns, and listen to stories—a *scop*, or poet, would recite lengthy story-poems while accompanying himself on a stringed instrument, or the hall guests would take turns reciting a verse or a song.

> We typically think of end-rhyme as being the defining factor of traditional poetry (for example, rhyming "seem" with "dream"). But instead, Anglo-Saxon poetry is driven by *alliteration* and *assonance*, the repetition of similar consonants or vowel sounds, often in pattern.

> After evolving, changing, and being lost and found again, Old English began to be studied in earnest from a scholarly perspective in the 1850s. Students at Oxford and Cambridge found value in studying the surviving poetry of the language that gave birth to the one we speak today. However, while Old English poetry is preserved through writing, it was never meant to be words on a page. It was composed, passed down, and treasured out loud. Old English poetry is sound.

> During the mid-19<sup>th</sup>-century revival, one student at Oxford explored this idea in depth and wove his linguistic findings into his own poetry, bringing it to a new echelon. His name was Gerard Manley Hopkins.

#### The Poet-Priest: Sound in Poetry

Gerard Hopkins was born in 1844 to Manley and Catherine Hopkins, a poet and a musician. Owing to the creative talent of his parents, Gerard grew up in a home accustomed to expressing beauty through both word and sound. After studying at Oxford (while the Anglo-Saxon revival was fully under way) and being ordained to the Jesuit Catholic priesthood in his mid-20s, Hopkins was transferred to Wales, where he encountered 14<sup>th</sup>-century Welsh poetry that developed his knowledge of historical linguistic poetic techniques.

Hopkins was decidedly not writing for silent consumers of poetry. This is easy to see in his instructions for "reading" different poems: in his letters to his good friend Robert Bridges, Hopkins often would accompany a new poem with an explanation of how it was to be read. His instructions sometimes approach those of a conductor to a singer: "take breath and read it with your ears," he says of the "Loss of the Eurydice," and of another poem, "it is, as living art should be, made for performance."



It is clear that Hopkins saw the transcription of his poetry as just that: a transcription, and the poems themselves could exist only in the minds and mouths of those who read them.

This idea of poetry as sound stemmed from Hopkins's study of Old English, shaped his writing and remains the most distinguishing characteristic of his work. In his most productive years, he developed a pattern of syllable

stressing he called "sprung rhythm": placing the emphasis on two consecutive syllables with no intervening unstressed syllable, in imitation of the sound of natural speech. For example, an excerpt from "Harry Plowman":

(Read aloud to sense the rhythm.)

"Hard as hurdle arms, with a broth of goldish flue

Breathed round; the rack of ribs; the scooped flank; lank

Rope-over thigh; knee-nave; and barrelled shank-

Head and foot, shoulder and shank-

By a grey eye's heed steered well, one crew, fall to;

Stand at stress. Each limb's barrowy brawn, his thew

That onewhere curded, onewhere sucked or sank-

Soared or sank—,"2

This meter is in sharp contrast to almost all English poetry since the turn of the first millennium: the normal poetic structure consists of repeating groups of two or three



**Figure 1.** Excerpt from "God's Grandeur" by Gerard Manley Hopkins showing consonant and vowel repetition. Upon reading it aloud it is clear that Hopkins relies upon this technique—both in this example and in his work as a whole.



**Figure 2.** Line 188 of Beowulf, in the original Old English and from Seamus Heaney's translation. Both are examples of alliteration and assonance.



syllables with the stressed syllable falling in the same place in every group, a pattern inherited from the Norman side of the English literary family tree. Hopkins believed for a time that he had invented the pattern of sprung rhythm, but upon returning to his books of Anglo-Saxon poetry, he later discovered that it was at least subconsciously inspired by his earlier study of Old English literature. He

wrote to Bridges, "So far as I know-I am enquiring and presently I shall be able to speak more decidedly-sprung rhythm existed in full force in Anglo-Saxon verse, and in great beauty."3 Hopkins's turn toward sprung rhythm marked a new dawn for poetic technique—the light of Anglo-Saxonoral poetry once again began to shine in English poetry. The technique that Hopkins intentionally borrowed from Anglo-Saxon verse is alliteration (Figure 1). The Old English oral poetic tradition was driven by this technique above all others, and Hopkins must have reached back into the volumes that held *Beowulf* to bring such verse technique to the present. He of course was not the first since pre-Norman times to use alliteration, but Hopkins's poetry is characterized by alliteration and assonance, as Anglo-Saxon verse was (Figure 2): it is difficult to find a Hopkins poem whose musicality is not formed by chords of delicately repeated consonance.

Unsatisfied with stopping at alliteration, Hopkins also explored the more melodic *cynghanedd*, a poetic technique of sound arrangement from Medieval Welsh poetry. Literally meaning "harmony" in Welsh, it usually refers to a pattern of consonants repeated within a line but can also use patterns of stress or rhyme. He went on to use the technique in his most iconic, memorable poetry.

(When reading examples, note that cynghanedd truly is a pattern of sound, and thus it helps to read the lines aloud. Note the pattern of emphasized—bolded—consonants that repeats within the line. All sounds are indicated by their appropriate symbols from the International Phonetic Alphabet.  $\delta$  makes the sound of the in "these", and tf the sound of the <ch> in "chip".)

From Hopkins's "Wreck of the Deutschland", stanza 2:

<u>The swoon of a heart that the sweep and the h</u>url of <u>thee trod</u>

 $\begin{array}{c} (\delta \ \textbf{sw} \ (n) \ (v) \ \textbf{h} \ (rt) \ \delta \ / \ \delta \ \textbf{sw} \ (p) \ (nd) \ (\delta) \ \textbf{h} \ (l) \ (v) \ \delta \\ (t \ ) \ (d) ) \end{array}$ 

From the same poem, stanza 7:

Warm-laid grave of a womb-life grey

 $\left(\mathbf{W}\left(r\right)\,\boldsymbol{m}\,\boldsymbol{l}\left(d\right)\,\boldsymbol{gr}\,/\,v\,\,v\,/\,\boldsymbol{w}\,\boldsymbol{m}\,\boldsymbol{l}\left(f\right)\,\boldsymbol{gr}\right)$ 

As shown here, Hopkins's use of cynghanedd is

often delicate enough that it shapes the mouthfeel of his lines without overburdening them with repetition. He also achieves this soft effect at times by pairing related (but not identical—for example, the voiced stops 'b' and 'd'; the labiodental fricatives 'f' and 'v') consonants for a less overwhelming alliterative effect.

In essence, for Hopkins, the very soul of poetry was intertwined with spokenness and sound. "Poetry is the darling child of lips and spoken utterance," he wrote to his brother Everard. "It must be spoken; till it is spoken it is not performed, it does not perform, it is not itself."<sup>4</sup> His use of sound pattern is what makes his poetry so much fun to speak, so memorable, and so easy to repeat (Figure 3).

#### டி

dъ

#### The Windhover (to Christ our Lord)

Gerard Manley Hopkins

I caught this morning morning's minion, king-

dom of daylight's dauphin, dapple-dawn-drawn Falcon, in his riding

Of the rolling level underneath him steady air, and striding

High there, how he rung upon the rein of a wimpling wing

In his ecstasy! then off, off forth on swing,

As a skate's heel sweeps smooth on a bow-bend: the hurl and gliding

Rebuffed the big wind. My heart in hiding

Stirred for a bird, – the achieve of, the mastery of the thing!

Brute beauty and valour and act, oh, air, pride, plume, here

Buckle! and the fire that breaks from thee then, a billion

Times told lovelier, more dangerous, O my chevalier!

No wonder of it: shéer plód makes plough down sillion

Shine, and blue-bleak embers, ah my dear,

Fall, gall themselves, and gash gold-vermilion.

**Figure 3.** The Windhover (to Christ our Lord), one of Hopkins's later poems, exemplifying all techniques discussed thus far.

#### Cynghanedd in the 21st Century

Fast forward to 2015: After receiving a copy of Taylor Swift's album *1989* for Christmas, my roommates and I played it on repeat, singing along enthusiastically. A phrase from one song continually insisted upon being stuck in my head, an inescapable earworm that lasted days on end. Which phrase? The first line of the chorus from Swift's song, "Style": "You've got that James Dean, daydream look *in your eye*...<sup>75</sup> After singing the line a few (dozen) times one day, a light bulb went off. I stopped, startled.

*James Dean . . . daydream . . .* It was the same pattern of *cynghanedd* found in Hopkins, which in turn was inspired by Old English oral poetic techniques.

James Dean, daydream

 $d_{3}(m) \mathbf{d}(n) | \mathbf{d} d_{3}(m)$ 

Even the pattern of vowels repeats symmetrically:

eI

James Dean, daydream

i: | eI i:

Perhaps I should not have been so surprised to realize it, but as exemplified in "Style," the same sound patterns that get stuck in our heads today have been playing in the memories of their hearers for more than a thousand years. Hopkins simply took note of memorable patterns and intentionally crafted lines with words that fit in sound, meaning, and meter as a jeweler chooses gems which together adorn a crown.

#### **Hopkins's Echo**

Lp.

After a short but intensely fruitful poetic career, Gerard Manley Hopkins died of typhoid in 1889. He had invented his own terms in philology, sought a revitalized language for poetry, and-most significantly-delved into the springs of the English language in search of treasure to inspire modern literature. He understood that language has the power to shape how we perceive and interact with the world. Hopkins was a thinker, a musician, a linguist, a priest, a writer. His poems are pictures: he paints with sound. He was a lyric writer of evident genius. He cracked the code of the ancient bards, the patterns of lyric poetry that stick in our minds-he understood and re-created the effect felt intuitively by anyone who has ever heard lyrics he could not forget. Hopkins remains a herald of the Old English language, echoing its poetic beauty and extending the legacy of unforgettable lyric technique into our world today.

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## JOURNEY TO THE EAST: UNDERSTANDING A CHINESE CLASSIC AS AN AMERICAN

## **Claire Casey**

s the diversity of our community increases, people encounter different cultural views on a day-to-day basis. We need to learn to communicate and cooperate with individuals who have different cultural perspectives. However, we have to escape our own cultural perspective to do so. We need to look beyond our own paradigm so that we can comprehend and interact with others, and the field of folklore is a spyglass through which one can view this process.

Folklore includes any performance of culture—a song, a story, a ritual, or a greeting—that is not institutionalized. The "folk" in *folklore* includes the individuals who participate in the performance. "Folk" and "folklore" are not limited to rural populations or tribal societies; urban legends and college traditions can be considered folklore just as easily as a fairytale.

*Journey to the West* follows the pilgrimage of Tripitaka, a Buddhist monk, as he travels to India to bring Buddhist scriptures back to China. Containing demons, spirits, dragons, talking animals, and trips to both heaven and the afterlife, this tale is clearly fictional. However, the central figure in the story, Tripitaka, is based on a real monk who completed this Buddhist pilgrimage in the 600s.<sup>1</sup> *Journey to the West*, as it is recognized today, was published in the 1500s by Wu Ch'êng-ên.<sup>2</sup> Though some episodes are lost in Arthur Waley's abridged English translation, *Monkey*, much of the overall meaning of the story is maintained; thus, the novel was made more accessible to individuals unfamiliar with Chinese culture.

The title of Waley's translation may appear odd from the description of the journey why is a book about a Buddhist pilgrim traveling to India called *Monkey*? In the novel, Tripitaka has three disciples to assist him-Pigsy, Sandy, and Monkey-as well as a dragon who is turned into a horse. Each disciple previously transgressed and is offered redemption by aiding Tripitaka on a perilous journey. Monkey, however, receives special attention in this work. The first seven chapters are dedicated to Monkey's story, and he serves a greater role throughout the novel. In fact, he often outshines Tripitaka and the others.

Journey to the West continues to thrive in Chinese pop culture, with many modern renditions of the story focusing on Monkey as the protagonist. The fascination with and love of this character are part of what makes Journey to the West such an enduring work. The character named Monkey acts as a cultural bridge because while he represents Chinese folk elements he is also a figure found in many cultures: the trickster. Monkey is more accessible to an audience unfamiliar with Chinese culture. Once acquainted with Monkey as a trickster, readers can start to examine the character within the religious context of the novel. Monkey's role within this context will illuminate Chinese religious values.

Trickster figures have been the center of many scholarly works, but no single definition of the trickster exists; however, certain characteristics are commonly noted. Barbara Babcock-Abrahams compiled some of these characteristics, including the following: "independence from . . . temporal and spatial boundaries"; a tendency for scatological incidents; a fluid physical form that can include transformations, disguises, and multiplicity; "an human/animal dualism"; and existence between life and death.<sup>3</sup> Without a singular definition of tricksters, Michael Carroll suggests the use of multiple trickster categories to analyze particular characters.<sup>4</sup> One category of which Carroll speaks is that of the "culture hero" who acts, often inadvertently, to further civilization through his or her tricks by "clearing the land of obstacles and monsters" or "instructing humans in useful activities."4 Monkey illustrates all these traits.

Monkey best demonstrates his skills as a trickster in chapter 5 when he creates chaos in heaven. Monkey desires a position in heaven, even going by the name "The Great Sage, Equal of Heaven," and is finally appointed to watch over the peach garden in which the peaches of immortality grow.<sup>2</sup> Monkey proceeds to eat the peaches, crash the heavenly feast at which the peaches were supposed to be eaten and to which he was not invited, drink all the alcohol, and steal and eat Lao Tzu's\* elixir of immortality "as if they were beans."<sup>2</sup> After this escapade, Monkey returns to his earthly home only to decide to depart again for heaven. The hosts of heaven are understandably upset with Monkey's actions and capture him with a great deal of difficulty. He is then taken to Buddha to answer for his crimes. Instead, they make a bet. Buddha tells Monkey that if Monkey can jump out of Buddha's palm, then Monkey will win the throne of heaven. Monkey leaps 108,000 leagues reaching five pillars at which he signs his name and, "to mark his disrespect," he urinates on them.<sup>2</sup> After leaping back to Buddha, he discovers that the five pillars were Buddha's fingers-he never left Buddha's palm at all. At this point, Buddha traps Monkey under a mountain until he is released to assist Tripitaka.

## "Monkey is free in a way that many humans wish to be, no matter their culture."

This episode characterizes Monkey as a trickster. He repeatedly changes his form throughout his tirade, demonstrates an immense appetite, and even becomes a cultural hero by fighting monsters and assisting Tripitaka to retrieve scriptures. His most important characteristic, however, is the repeated sense of liminality: being between or along a boundary. Before choosing to eat the peaches, Monkey simultaneously discards his clothing and his self-control. Therefore, Monkey crosses from human to animal. This human/animal dualism is further emphasized by the fact that he is sometimes portraved as an actual monkey and other times as a human with monkey-like features. Monkey's newfound immortality surpasses the line between life and death while the ease with which he comes and goes from heaven confuses the boundary between sacred and profane. Identifying Monkey as a trickster, particularly his liminality, allows us to understand his significance before using the details of his story to understand Chinese culture.

Viewing Monkey as a trickster also initiates our shift from American to Chinese cultural viewpoint owing to conflicting attributes associated with monkeys. Monkeys are juxtaposed with humans in many cultures; however, this comparison is often negative in American culture and suggests being uncivilized, unintelligent, or unevolved. These negative connotations are most evident in the use of monkeys in Western racial propaganda.<sup>5</sup> By contrast, monkeys in Eastern cultures are often highly regarded rather than viewed as frivolous.<sup>5</sup> In Journey to the West, Monkey is associated with the human mind, and like the

human mind he "is full of pranks, of human frolic, and among the lower classes it was this aspect, rather, which received the most attention."<sup>6</sup> Monkey's cleverness is emphasized so that his mischievousness elicits sympathy—even empathy—from the reader, as he is crafted into a representation of the common person.

Before exploring the significance of this, we must define the cultural context. Because we cannot come to comprehend an entire nation's religious traditions in one day, we must satisfy ourselves with the essentials. China has a rich religious tradition that includes multiple religions, the most prominent of which are Buddhism, Confucianism, and Taoism.<sup>7</sup> These complex belief systems affect and interact with each other and Chinese society dynamically. Throughout China's history, each of these religions was at some point considered the most superior depending on the political environment.<sup>7</sup> On the elite level, these traditions remained largely distinct. In contrast to the elite, these traditions became mixed on the folk level and combined with other folk beliefs.8

Two notable folk beliefs are the five elements and the twelveanimal zodiac. The five elements include wood, earth, water, fire, and metal, and each element has a particular relationship with each other element. The five-element cycle was employed in almanacs to make predictions and thus popularly used to address daily activities.<sup>9</sup> The five-element system is therefore considered a folk belief. The elements also play a role in the Chinese zodiac since each animal is assigned an element. Like most

<sup>\*</sup> Considered the founder of Taoism.<sup>10</sup>

astrological systems, the Chinese zodiac was also used by the folk to predict the future.<sup>10</sup>

The emphasis placed on the zodiac and the elements both in Chinese culture and within Journey to the West serves as a natural transition through which we can place Monkey into the Chinese religious context. He is a monkey, after all, and monkeys are one of the twelve zodiac animals. Monkeys are associated with metal<sup>10</sup> and our Monkey certainly is as well; Monkey's weapon of choice is a large iron cudgel and he is given iron pills to eat and copper juice to drink during his jail sentence.<sup>2</sup> The other pilgrims are also associated with elements. Sandy, as his name would suggest, is earth. Pigsy, who was "in command of all the watery hosts" of heaven,<sup>2</sup> is water, as is the zodiac

Monkey is often the one guiding Tripitaka in spite of the fact that Tripitaka is the master. This elemental relationship directly reflects Monkey's liminality, allowing him to alternate between master and student as he does between human and animal. Monkey further steps beyond his role as pupil by acting outside the priestly behavior Tripitaka prescribes. Tripitaka states that "a priest . . . should be ready to die rather than commit acts of violence" and that "abstinence from wine was the first rule of priesthood."2 However, Monkey continuously kills to protect the pilgrims and thoroughly enjoys wine—yet he becomes a Buddha by the end of the novel. Monkey's success despite his liminal behavior, acting outside accepted boundaries, produces this role reversal between master and student.

"Monkey is a perfect cultural bridge because while he represents Chinese folk elements he is also a figure found in many cultures: the trickster."

pig.<sup>10</sup> Like the zodiac horse, Horse is fire.10 Tripitaka, whose childhood name was River Float, is therefore wood. The pilgrims's relationships are marked by those of the elements. In the element cycle, metal shapes water.<sup>9</sup> Similarly, Monkey (metal) shapes Pigsy (water) in the sense that he encourages Pigsy's appetite and tricks Pigsy into participating in his schemes. Consequently, Monkey's presence exaggerates Pigsy's characteristics, especially his foolishness. On the other hand, metal counteracts wood by cutting it.9 Thus, Monkey (metal) counteracts Tripitaka (wood). For example, when Tripitaka becomes despondent while facing an overwhelming obstacle, Monkey responds with agitation and motivation.

Together, Monkey's liminal nature and his ties to Chinese folk belief emphasize the importance of combining religious traditions within Chinese folk religion. Despite becoming a Buddha, Monkey learned his ability to transform from a Taoist patriarch. He defies Lao Tzu by stealing his elixir of immortality, but Monkey also defies Buddha by urinating on him. As a trickster, Monkey lives both within and without religious restrictions by using and defying multiple traditions.

That behavior illustrates the folk tradition of borrowing beliefs from all three of the dominant religions. One particular episode, the Cart Slow Kingdom, especially emphasizes Monkey as an advocate for religious synthesis. In this episode, three spirits disguised as Taoist immortals take control of a city and oppress Buddhists. Monkey defeats the imposters and, though he states that "Buddhism is the true way," he also states that "the Three Religions are one. Reverence priests, reverence Taoists, too, and cultivate the faculties of man."<sup>2</sup> Since Confucianism emphasizes selfcultivation, it too is included.<sup>1</sup> Thus, Monkey serves to reinforce the folk religion that synthesizes rather than divides Confucianism, Buddhism, and Taoism alongside folk beliefs.

Monkey's dualism illustrates particular characteristics not only of Chinese culture but also of human nature. When we look at all aspects of Monkey's liminality, we see that he is somewhere between human and animal, master and student, Earth and heaven, life and death, as well

> as being both within and without religion. The human mind, too, desires to be free of such boundaries. Monkey achieves the position of Buddha despite, at times, shedding his human characteristics in favor of animalistic indulgences.

He can relish this world without jeopardizing his place in the next, as his free travel between Earth and heaven demonstrates. Even death cannot tether him. Monkey is free in a way that many humans wish to be, no matter their culture. By speaking to human nature, *Journey to the West* has found its way into American pop culture as well, offering a cultural bridge between China and America.

To work together, we must all understand how our cultural perspectives differ and how they are similar. Monkey demonstrates both commonality when viewed first from the outside as a cross-cultural figure, then the uniqueness of Chinese folk religion, and finally the desire of many people for freedom, allowing us to understand where American and Chinese cultures overlap. A similar understanding is important whether one is handling international affairs or a colloquial exchange between strangers. Both parties must comprehend the similarities and differences between their cultural perspectives for optimal communication and cooperation to occur. As shown here with *Journey to the West*, studies within the humanities are windows into intercultural relations and as such are integral to the function of our global community.

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## Lowering the Age on Crime: An Assessment of Juveniles's Responsiveness to Heightened Criminal Sanctions

## **Brenton Cooper**

#### Introduction

Nationwide, the early 1990s marked an increase in the rate of violent crimes committed by individuals between the ages of 10 and 17. In 1995, this rate stood at 490 offenses per 100,000 juveniles, up from 330 offenses per 100,000 juveniles in 1988.<sup>1</sup> States responded to this rise with several policy changes in a nationwide effort to "get tough" on crime, and this response assumed that more punitive sanctions deter crime.<sup>2</sup> One such change was the lowering of the maximum age of juvenile jurisdiction, which is the highest age at which individuals can be tried in juvenile courts. The change pushes more and younger offenders into the adult criminal and judicial systems. In 1993, Wyoming lowered its maximum age of juvenile jurisdiction from 18-years-old to 17-years-old, thereby excluding all 18-year-olds from the juvenile court system. In 1995, New Hampshire and Wisconsin followed suit each by lowering its maximum age of juvenile jurisdiction from 17 to 16 years.<sup>3</sup> My research shows that the effect of these policies in deterring crime was negligible in both the short term and the long term.

For several reasons, we need to study whether these policies achieved their intended goal of deterring crime. First, stiff sanctions on juvenile crime come at extremely high costs to the youths themselves and to society at large. Juvenile incarceration causes lower rates of high school completion and higher rates of adult recidivism.<sup>4</sup> Juveniles are also 7.7 times more likely to commit suicide in adult jails than in juvenile jails.<sup>5</sup> Other costs are borne by taxpayers. For example, for fiscal year 2012 in Texas, it cost \$50.04 per inmate per day to run the adult corrections system. The more expensive of the state's two juvenile systems costs only \$29.78 per inmate per day.<sup>6</sup> Knowing whether any of these higher costs are justified by a significant deterrent effect is important.

This research also clarifies whether the assumption of rationality applies to criminal behavior among juveniles. A great body of crime research and policy implementation rests on the theoretical formulation of Becker.<sup>7</sup> This theory asserts that individuals act rationally in committing crimes, weighing the expected marginal costs and benefits of each

criminal act. The adult criminal system raises the "price" of crime since, unlike the juvenile system, it does not seal any criminal record histories and since it generally gives more punitive sanctions.<sup>8</sup> Under this theory, if juveniles act rationally, this rise in the cost of crime should decrease the amount of crime committed.

#### Background

Research on this topic seems to support the idea that harsher sanctions decrease crime. Levitt studies the juvenile crime rate as a function of the punitiveness of a state's juvenile crime system. When a state imposes more punitive sanctions, that state sees less crime in later periods. His study holds constant other variables, including race demographics, age demographics, and economic conditions. In other words, when states have the same value for all these other variables, yet differ in their punitiveness, states with the more punitive systems eventually see less crime. This strategy isolates the effect of punitiveness from the many other variables that could affect the crime rate.<sup>9</sup>

In a forthcoming paper, Benjamin Hansen and Glen Waddell study minimum sentencing laws in Oregon that apply to all individuals of age 15 or older. They use a strategy that observes the difference in crime rates between individuals who are just under 15 years of age and those who are just over 15 years of age. Theoretically, the individuals on both sides of this line should be the same in every respect except that the latter group receives harsher criminal sanctions. Like Levitt's strategy, this strategy separates the effect of adult sanctions from other variables that could influence the juvenile crime rate. Although this policy deters crime, it does so only for the most serious crimes with the harshest penalties.My research adds to the literature by studying not an existing policy, but a policy change. This approach adds value since it helps show whether a deterrent effect exists in the short term that dies out in the long term or-conversely-whether juveniles immediately respond to the policy by committing less crime before eventually resuming prepolicy behavior. The results show that a deterrent effect is present neither in the short term nor in the long term.



**Figure 1.** This graph shows the fluctuation in crime rates among 17-year-olds in Wisconsin and Nebraska. At the policy change, marked by the vertical reference line, 17-year-olds in Wisconsin fully enter the adult judicial system while their Nebraskan counterparts are still under juvenile jurisdiction.

#### Results

The first application of the strategy establishes Nebraska as a counterfactual for Wisconsin. The results from this comparison show that, after January 1996, juvenile crime rates in Wisconsin did not decrease in the short term in relation to the Nebraska rate (Figure 1). I also compare this treatment group with the control groups of 17-yearolds in New York and in Iowa. Comparisons with New York support the same conclusion that this policy change did not affect the juvenile crime rate. Comparisons with Iowa show that the policy did have an effect. However, too much divergence between the groups is evident leading up to the policy change, and so Iowa cannot be said to be a counterfactual for Wisconsin. Expressing this strategy as a regression supports these same conclusions. I also use the treatment group of 18-year-olds in Wyoming. To satisfy the requirement that crime rates fluctuate similarly leading up to the policy change, I use the single control group consisting of both 17-year-olds and 16-year-olds in Wyoming. These results confirm the conclusion drawn

## "...stiff sanctions on juvenile crime come at extremely high costs to the youths themselves and to society at large."

#### Methods

My study uses several applications of a difference-indifferences design. This design identifies a treatment group that, at a certain point in time, becomes subject to a certain policy. The design compares this treatment group with a control group that does not undergo the policy change. For example, the first application uses 17-year-olds in Wisconsin as its treatment group. In January 1996, this group moves from juvenile to adult jurisdiction. I compare this treatment group first with the control group of 17-yearolds in Nebraska, who are subject to juvenile jurisdiction throughout the period studied. Nebraska's crime rate after January 1996 shows-theoretically-what would have occurred if Wisconsin did not lower its age of criminal majority. Nebraska serves as a control group that captures the effect of all variables acting upon the crime rate in both states, including demographics, economic conditions, and seasonal fluctuations. If, after the policy change, the crime rate in Wisconsin decreases in relation to the crime rate in Nebraska, the policy can be said to be effective at deterring crime. If similar fluctuations occur after the policy change, the policy probably has no effect. This strategy requires that the two groups exhibit similar fluctuations in outcomes leading up to the policy change. If so, the control group can be said to be a counterfactual for the treatment group. However, if crime rates in the two groups converge or diverge before the change, any difference between them after the policy change is probably the result of a factor other than the policy itself.

from Wisconsin that the effect of moving youths to the adult criminal system in 1994 is negligible (Figure 2). Also, the results from Wyoming show that this lack of an effect holds for both the short term and the long term after the policy change. Again, a regression-based analysis using this strategy confirms these conclusions.





**Figure 2.** This graph shows the fluctuation in crime rates among Wyoming 18-year-olds and the group consisting of Wyoming 17- and 16-year-olds. At the policy change, marked by the vertical reference line, 18-year-olds fully enter the adult judicial system while their Iowan counterparts do not.

#### Conclusion

The weight of the evidence supports the position that lowering the maximum age of juvenile jurisdiction and trying juveniles in the adult judicial system does not cause a decrease in overall crime. Three of the four applications of the design show this policy having no effect. The only application that shows an effect—Wisconsin vs. Iowa—is not as reliable as the others since the crime rates of the two groups diverge before the policy change. These results are important in light of the high costs imposed on juveniles, taxpayers, and society at large by trying young people in the adult system. These results also cast doubt on the idea that we can extend the assumption of rationality to behavior among juveniles—at least in this context.

## "Research shows that stiffer sanctions do affect more serious crimes."

However, lowering the maximum age of juvenile jurisdiction is a broad, wide-sweeping strategy. Research shows that stiffer sanctions do affect more serious crimes. Despite failing to lower the overall crime rate, lowering the age of criminal majority may affect certain crimes. A limitation of this study is that it cannot specify why these policies fail to deter crime. Juveniles may simply be unaware of the policy changes or they may fail to respond to the policy changes, despite knowing about them. This question requires further research.

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**Michael Martin** 

# George Crooner

"George Crooner" is a short essay I wrote for Dr. Killingsworth's Rhetoric of Style class (ENGL 355) in the spring 2014 semester. Dr. Killingsworth's exuberant teaching style allowed me to feel comfortable writing personal, creative work under the direction of his expertise. Creative writing has always been my favorite form of scholastic development, and throughout elementary, middle, and high school I eagerly wrote stories and poems. I found my principal inspiration within the art of storytelling, both written and oral, and gravitated not only toward writers such as Dan Brown and Stephen King but also toward actors such as Kevin Spacey and Heath Ledger—among innumerable others. I combined the concept of delivery in storytelling with the agents that conveyed it, creating what I felt to be a natural conduit for a story with impact.

When I began my freshman year at Texas A&M I had initially abstained from writing, music, and other artistic endeavors in favor of pursuing a degree in mechanical engineering. But my shortcomings in the realm of mathematics quickly reminded me that I was out of my element. I painfully transitioned from major to major until I accidentally

found my way to the English department and once again had the opportunity to write academically, this time under the direction of wise and talented professors.

The "George Crooner" story evolved from my experience as a musician and my take on what it might be like to be a "branded" musical act, one with international fame and stratospheric success, and how the person behind the art might not reflect the person we see. Dr. Killingsworth's writing and affinity for rhetoric greatly influenced how I approached this piece, and under his direction I felt encouraged to dig at the core of what made a man like George Crooner tick. I wanted to create a wormhole within the universal understanding of superstardom that allowed the reader to live vicariously moment to moment inside George's head, humanizing him in the process, I hoped. By riding along inside his psyche, the audience has the opportunity to experience his gilded, vulnerable personality, a stark contrast to his perceived public image in the prologue.

I chose the third-person perspective to allow the reader to interpret George Crooner's ruminations in real time, as well as adding the level of omniscience to allow a direct experience through his grasp on reality as it falls farther and farther from his control. The style also allows the reader to make conjectures from subtle incongruities about our preconceptions of the glories of fame compared with what it might actually be like from a firsthand perspective.

As humans, we all encounter our own existential crises from time to time, and I used this sensation to drive my essay toward that common resonance. I pulled heavily from my own insecurities about failing to succeed in mechanical engineering and the immense weight of desiring a successful career in the music industry without making meaningful progress. I wrote the essay to verbalize the psychological struggle that I, like all of us, have encountered when tasked with making life-changing decisions and to offer a relatable and entertaining story to show that even those who seem to have it all may, in fact, not. I aim to have succeeded in giving readers the chance to explore their sense of private humanity within the piece and to empathize with failure in a way that reveals that they are not alone, that even the superstars of our world may not have it all together.



## "... the person behind the art may not reflect the person we see."

He is pearl cuff links on a three-piece suit. He is nine different forks, knives, and spoons at the dinner table. His suit is stitched with pure class, and his black-and-white ensemble polarizes his prestige above those around him. His expression is smooth and sincere, perpetually composed. His eyes are soft, and his hair is carved marble. His movements are as sure as his wit: effortless, perfect, legendary. He is an all-American man, a lover of baseball and good values and hard, honest work. He is the man all the women want and the man all other men want to be. He is the standard by which everyone is judged.

Standing behind an iconic Shure Super 55 microphone, he materializes before the audience, all drowning in opulence and waiting with bated breath to see him. His figure is stoic, larger than life. Women in long dresses and men in pressed tuxes collectively inhale with a loud gasp and then exhale into thunderous applause as he takes the stage. His mouth opens and the sound that fills the room is leather, scotch, cigars, and sincerity. Hearts melt; eyes well. George Crooner has arrived.

\* \* \*

The back of the limousine was swathed in wavelike velvet curtains, shielding the man inside from the December twilight that had descended like a ghost. The cerulean hue from the recessed lighting overhead cast a dim spotlight on the empty seats around him, each with its own empty crystal chalice. The luxurious compartment had enough room for ten more people, but the man preferred traveling alone. It was one of only a few requests he made. He saw himself as a simple manwhatever that meant in this industry—needing nothing more than a quiet ride, some privacy, and a bottle of scotch for companionship. As the long vessel rolled into the back entrance of the venue, he took a final sip from the sweating glass in his hand, delighting in the pleasant burn as it slithered down his throat. A garage door groaned shut behind them, sealing away the bitter darkness, and he relished his precious isolation for a final moment inside before the heavy door swung open. A white glove was resting on top of the door, attached to an unblinking man in a smart black tux. The chauffer's ensemble resembled the one he would be wearing that evening, but he assured himself that his was a mark of success, not servitude. He emerged from the limousine, straightened his bowtie, and set his gait to glide across the concrete floor toward the double doors.

The green room was brightly lit. A liquor cart, dressed like a butler, stood idle by a mature leather lounger with mahogany inlays. Before it stood a tall mirror crowned with beaming incandescent bulbs, and as he got closer to it his face took on the photogenic hue he saw so often in pictures of himself. They were everywhere, those pictures. Turn a corner, poster; passing a newsstand, magazine cover; watching the news, feature. His friends always asked him to sign photos for their families, and he always obliged. He didn't mind it. As far as he was concerned, it came with the territory.

He scanned his face up and down in the mirror. It looked mostly familiar. He thought about the last few times he had looked at himself before a show and remembered how there was something . . . off. Not wrong, necessarily, but just . . . strange. He saw a face, his face, certainly. But it seemed more like a character from a movie, an idealized poster-boy face that somehow didn't really belong to anyone—at least, not to him. It felt like his expression and his jawline and his blue eyes and his stern yet forgiving brow had all been masterly drawn over his real face and set to strike the pose. Of course, he had trained his face to look like that, what with all the photographs and public appearances he had to make. It came with the territory.

He took a seat and poured himself another scotch. He filled it just a little higher than usual, 'cause what the hell? It tasted like it always did, like wealth and class. He wondered for a minute where this bottle even came from, before an abrupt knock at the door wrenched him from his thoughts. "He is the man all the women want and the man all other men want to be. He is the standard by which everyone is judged."

"Yes?"

Inside his head the word sounded normal, but the echo from the concrete walls crooned back, ". . . Yeesss?" The pitch held for just a moment, suspended in midair before shimmering away into the white noise of the room. He didn't even mean for it to sound that way, but—much like his face—his voice was always in gear, as if the cruise control had gotten stuck fifteen years ago and was never repaired.

"There are a few young ladies who are very excited to meet you. Is now a good time?" A voice said from the other side.

"Of course, send 'em on in! I always have time to chat." He never refused fans. It was more out of politeness than preference, and it wasn't that he couldn't say no but that he wouldn't.

"Mr. Crooner, this is Miss Powell, Miss Bennett, and Miss Jennings. They're very big fans of yours."

"Please, call me George." Immediate, automatic charisma. It was like a switch in his head that got flicked on every time he met people who already knew who he was, but nowadays that was most everybody he met. He politely agreed and routinely charmed them, affirming their adulation by returning their compliments, just like he always did. He was just barely engaged enough to convince them he was paying attention, but he was really glancing just over their shoulders in the mirror, watching himself talk with the young ladies. They had unrestrained excitement, like puppies in dresses. Then he focused on himself for a few seconds . . . and what he saw frightened him.

There he was in a perfect black suit with perfectly shined shoes and carved marble hair and a velvet-red bowtie. His eyes lit up like stars. His expression was smooth as caramel and just as sweet. He realized he was looking at the man everyone knew as George Crooner, reacting and gesturing as if every tiny move were scripted. The real George was drawn to the scene playing out in the mirror ten feet behind the bespangled puppies, watching in awe as his caricature effortlessly melted their furiously beating hearts. He broke his gaze with the stranger in the mirror and tried to refocus his attention on the trembling fans before him. He signed their programs and gave each a warm hug, filled to the brim with feigned affection.

The image in the mirror was still branded in his memory, but the girls had exited none the wiser, too busy tossing incredulous looks among themselves as they reminisced of the meeting. He returned to his chair, but right before sitting down he leaned in close to the mirror. He examined his face once more, checking for leaks or cracks that might be letting that terribly enchanting man slip out when people were around. He could find none. A little irritated, he sat back fast in his chair and slumped, truly confused. He pondered until show time, and then he had no more time to ponder. It always seemed to go that way, but he retired his argument all the same and put on his stage face—intentionally this time.

The show went as it always did. People came to see George Crooner and left, excited that they got to see *the* George Crooner, the very same George from the television, from the magazine, the radio. They came as if to verify for themselves that he actually existed and that it wasn't some elaborate ruse. Even though he had performed countless times for innumerable dignitaries and politicians across the world, George had no interest in their politics. But his fans did, so sometimes he put on his face and made statements that would boost ticket sales and polish his public image. Then, he took off his face and thought about the people who did care about politics and whether they were more satisfied with their lives than he.

He came off stage and took a right for the green room. The encore was still stuck in his head, and he smiled as he thought about the crowd, fifteen hundred strong, and laughed to himself about how crazy all this truly was. He could still do that; laugh at being grotesquely paid to sing for a living. He loved it, he truly did, but they didn't love him. They loved George Crooner, the consummate singer and handsome ladies's man, but not George. They loved a good show, and he gave them what they wanted and a face to go with it.

He grabbed his coat and cigarettes and turned for the door, catching himself once more in the mirror. He scanned the reflection up and down but could find no sign of the stranger he'd seen before. Disgruntled, he shrugged it off, set his gait once again, and slid into the hallway toward the double doors that

guarded the waiting limousine. He had almost made it there when his pace suddenly slowed, decelerating to a stop inches before the door. He stood like a statue, arm extended, ready to breach the barrier that led to his solitary ride back to his solitary estate, but he couldn't bring himself to move a hair farther. He was stuck inside his head, staring blankly past the brushedsteel exit into nothingness. In an instant he about-faced, forgetting to reset his gait, and gracelessly scurried the opposite direction toward another door marked EXIT at the other end of the corridor.

His pace picked up to a run, then an all-out sprint, as if something were bearing down on him, and when he crashed through the door an icy, snow-filled gust wrapped around him and squeezed, making him shiver to the bone. He cowered under the ghastly streetlight, heaving, searching frantically for something familiar, an answer, anything at all to alleviate the overwhelming dread suffocating him. But the sky had no color and no life. The buildings were cold and dark. The street before him was empty. And at that moment, George was more alone, and more terrified, than he'd ever been.



"They loved a good show, and he gave them what they wanted and a face to go with it."

# MIDDLE EASTERN FEMINISM: gender quotas in jordanian politics

Mackenzie Kieborz

#### Introduction

Jordan, a relatively small country located in the heart of the Middle East, exists as an island of permanence and functionality in a region characterized by instability and turmoil. Jordan has a constitutional monarchy and a population of 7.9 million. That figure is in addition to almost 1 million documented refugees living on a piece of land slightly smaller than the state of Indiana, or roughly the distance from San Antonio to Fort Worth with the far Eastern corner being at Texarkana.

Although the Middle East is painted as an area with rampant oppression, Jordan has a progressive feminist policy that the United States lacks—a legal requirement for women's participation in the legislative process. Quotas, increasing in popularity

worldwide, come in many forms. Jordan's gender-based quota system is a reserved-seats quota, meaning that a fixed number of Parliamentary seats are reserved for women to hold. But the gender quota isn't the first quota Jordan had; a longstanding quota is in place for three minority groups: Bedouins, Circassian/Chechens, and Christians.

The political system in Jordan is complicated. King Abdullah II is the head of the government, with the



# "Jordan has a progressive feminist policy that the United States lacks"

prime minister, legislative branch, and judicial branch serving underneath him (Figure 1). Additionally, 12 governorates manage local government needs, similar to counties in the U.S.

The 150 deputies, or members of Parliament (MPs), of the lower house are elected in two main ways: through party lists and through local electoral districts. Jordanians have a single vote in each type of election—but those votes are nontransferable to other candidates (such as a second or third choice). In local districts, deputies are elected outright by the number of votes they receive, and on the party lists they are elected proportionally based on the number of votes the list itself receives, going down in order from the first name on the list.

Women are elected from every governorate and each Bedouin district, so that the woman with the highest percentage of votes from the general election in her district wins the quota seat for that governorate. Women run alongside the men in elections; however, they compete only against the women in their area. The 15 seats reserved for the quota is a minimum, not a maximum, so that a woman who wins a seat outright does not detract from the total number of quota

Figure 1. Jordanian Legislative Branch of Government.

Table 1. Higher Education						
	Women	% Women	Men		Overall	
Mean	1.5		1.47		1.48	
			p = 0.70			
Secondary (0)	1	6%	10	7.9%	11	
Bachelor (1)	9	50%	68	53.50%	77	
Master (2)	6	33%	28	22%	34	
Ph.D. (3)	2	11%	21	16.50%	23	
Total	18		127		145	

seats. Since King Abdullah called for a gender quota in 2003, three parliamentary elections have occurred. The number of seats for the genderbased quota has increased only to match overall increases in the total number of deputies.

In general, initial impressions of formal quotas are that internal political pressures would drive the quota adoption process. However, research by S. Bush<sup>1</sup> suggests that the motives for adopting gender quotas are strongly related to international incentives that work both through strategic quota adoption to signal of a "commitment to liberal democracy" and the promotion of gender issues by international actors within the country. The effect of these motives outweighed internal factors generally attributed to the desire for minority groups to be included in government. A quota is a quota—or is it? It is interesting to consider how the different motives for a quota might affect its many outcomes.

The overwhelming body of evidence suggests that woman representatives, whether elected by a quota or not, positively affect their countries. Women in government are tied to more female-friendly policies.<sup>2</sup> Moreover, they get women more involved by promoting political discussion.<sup>1</sup> Women attend more to infrastructure and they enhance the government by effectively implementing policy, increasing transparency, and fighting corruption.<sup>3</sup>

Jordanian citizens consider those actions the most important duties of MPs, so they would probably approve of active women MPs<sup>3</sup> in their own legislature. I first conducted local research in the spring of 2014. I concluded that the short time the female MPs have been in Parliament has not been enough to yield sweeping feminist or female-friendly police results. This outcome is primarily due to the fact that barriers for women in politics were high. Despite the barriers, the female MPs have made remarkable strides by organizing a Women's Caucus, strategically changing legislation to better represent women and their constituents overall,<sup>4</sup> and are approaching bigger issues deemed too complicated for their sex.<sup>5</sup>

The research I discuss here, conducted during the fall of 2014, set out to answer two main questions:

- 1. What are the female MPs like, and how do they compare to the male MPs?
- 2. How do the committee assignments of men and women compare?

The first question has a few possible explanations. The first is that the women are not as qualified as the men, therefore becoming "token women" who sit to fill numbers but have no real political impact. The second is that the women are more qualified than the men, suggesting they are held to a higher standard than male candidates. Finally, if the men and women have equal qualifications, the women probably could easily work within this maledominated sphere and produce changes. The third is that women would not have to be more qualified than men; it also means that they would be less likely to substantively represent their constituents (Why? This does not seem obvious-they could be equally qualified but have different agendas and areas

where they spend their political capital). Better understanding of the situation in Jordan allows for a critical examination of the quota and the types of women elected because of it.

#### **Results and Discussion**

Jordanian MPs do not differ on the basic demographic criteria by gender. Male and female MPs are about the same age, have the

same rates of marriage and level of education, list the same rate of party affiliation, and lack experience in

## "woman representatives,

Parliament. The average age of the MPs at election was 51.9 years; 86% of the MPs are currently married (Table 1); and 92.4% of MPs have at least a bachelor's degree, with the average education attained falling somewhere between a bachelor's and a master's degree (Table 1). The women don't tend to be older, more educated, or more independent of familial responsibilities than the men in Parliament. Plus, it is unlikely for any MP to have served a previous term in Parliament, regardless of gender. Even when multiple terms were accounted for, being reelected once or multiple times is not common for Jordanian legislators, and only just above a third of MPs had any previous experience

Also, no differences by gender exist in the number of previous jobs or civil society organizations the MPs are affiliated with. Men did list a wider range of responses, reporting zero to 20 previous jobs, whereas the women reported one to 12. The jobs listed included working in local government as mayors, lawyers, business owners, or in higher education as professors. The types that women listed spanned a variety of occupations from being lawyers and high-ranking medical officers in the military to teachers and social workers. Civil society organization affiliation also was diverse: some examples include union membership, charity work, and involvement with youth and sports organizations.

Since the women's profiles so closely match the men's, this strengthens support of the quota as a form of positive discrimination. The quota helps women who are as qualified as the men get elected, instead of promoting the election of unqualified "token women." Also, it seems that women can be elected without being held to a higher standard—they don't have to be prominent figures with a great deal of experience and a Ph.D. to be successful and win elections

## whether elected by a quota or not, positively affect their countries" or the appropriateness of

Comparing the men and women on committees yielded the most interesting results. During the first session of the 17<sup>th</sup> house of Parliament had 20 committees. Committees address a variety of issues, with the permanent committees being the Legal, Financial, Administrative, and Foreign Affairs committees, and others such as the Commission for Tourism and Antiquities, and the Committee on Women and Family Affairs. I expected that the male-tofemale ratio on committees would mirror that in Parliament, which consists of 88% men and 12% women (Figure 2). Indeed, the ratio of men to women was the same for committees. However, when you exclude the Committee on Women and Family Affairs, composed of nine women and two men, the gender ratio shifts so that 91.3% of committee assignments are men and 8.7% are women (Figure 2). The specific backgrounds of the female MPs are consistent with their respective committee assignments,



#### Figure 3. Distribution, by Gender, of Committee Leadership.

so it is not entirely surprising for the unequal distribution of women on some committees and absence from others

> Women did have significantly higher levels of expertise, their respective committee

assignments, than the men. I calculated the expertise or appropriateness level of the MPs committee assignments by giving them a score of either zero or one in four areas: education, previous employment, civil society organizations, and regional relevance. The regional relevance accounts for situations when the district location of the MPs superseded his or her background or education—for example, the MP from Jordan's major tourist location should sit on the Tourism and Antiquities committee even without any relevant education or work experience. A zero score signified experience not related to the committee assignment, and a 1 signified relevant experience. The values were then added to create the composite appropriateness level for each MP, accounting for each of the four areas.

Woman MPs's appropriateness or expertise for their assignments was significantly higher than the men's. Though women may not be members of all committees, they are assigned to

		Percent Breakdown in Parliament	All Committee Breakdown	Committee Breakdown Excluding Women/ Family Committee	
	Percent Men	88	87.7	91.3	
	Percent Women	12	12.3	8.7	

Figure 2. Breakdown, by Sex, in Parliament and in Committees.

committees that fit their educational background, employment history, civil society organization affiliation, and possible regional relevance better than the men. This shows that solely on the basis of the information from their profile, the women are more qualified for their committee assignments than the men. Women are not discriminated against in their committee placement and have a higher chance than the men of getting placed on a committee relevant to their background. It is not clear whether this translates to real experience in every case, and it may be that women better represent their backgrounds to match their committee assignments.

Furthermore, I analyzed the leadership roles of committee members. Each committee has a chair (the highest position), a vice chairman, and a commission decision delegate. Again I found no significant difference between male and female MPs in their leadership positions. Men did have overall higher-ranking leadership positions, as was expected by the historic presence of men in Parliament, yet a higher percentage of female MPs serve on committee leadership than men. However, women do chair committees, such as the Committee for Public Freedom and Human Rights, the System Committee and Behavior. and the Committee on Women and Family Affairs, and hold leadership positions on many other committees. Women are also leaders of both permanent committees and those that are important to constituents.

The fact that women are not barred institutionally from being effective MPs by being pigeonholed in marginal committees or not appropriately

placed on committees speaks greatly to the acceptance of women by the Parliament. Also, although men have slightly higher leadership positions on committees, no significant genderbased difference in committee leadership is apparent, showing that female MPs have access to formal positions of leadership in Parliament

The results from this analysis establishes an objective descriptive groundwork and foundation so that further research can increase the depth and breadth of understanding the role of a person's sex in politics. This work applies directly to the effect of the quota on legislature and its outcomes as a feminist mechanism for change.

These results also offer context for the representativeness of the Jordanian legislature and the way the quota may affect substantive representation. Since I found the backgrounds of women to be the same as the men's, the women might not be bringing significantly different backgrounds or behaviors to Parliament. This factor could possibly both directly and indirectly affect women's issues in Jordan. It is interesting to examine this information with the context provided from my findings in the spring of 2014,<sup>6</sup> such as how women are working to bring women's issues to Parliament. They are also working to improve both their qualifications and their expertise through workshops and trainings and through building a network of women within Parliament through the Women's Caucus.

#### Conclusion

Looking comprehensively at the situation in Jordan suggests that the women are in a position not only to keep up with the men but also to be representatives of both their constituencies and of Jordanian women. The quota has allowed women who are as educated as the men, the same age, have similar political party affiliation, and who report the same number of previous iobs and civil society affiliations to enter into elected office. The women and the men have the same chance of being reelected and they are for the most part proportionally represented in committee membership. Women

are more likely than men to get a committee assignment relevant to their experience. Women are underrepresented in committees, excluding the Committee on Women and Family Affairs committee. This is reasonable considering their backgrounds, but slightly concerning. The backgrounds of Jordanian MPs match the findings of Schwindt-Bayer in Latin America, who describes the men and women in government as more similar than they are different.<sup>7</sup> The future of woman politicians in Jordan and the world has a sturdy foundation for further development and growth, and with the fervent efforts by women and their supporting organizations, real social change is possible.

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Audrey Vincenzo

**OVERLOOKED** 

20

#### OFTEN,

DETAILS THAT MAKE UP SURROUNDINGS BLEND BACKGROUND AND ARE AS ORDINARY.

his photograph was inspired by Georgia O'Keeffe's painting "Purple Petunias." Georgia O'Keeffe once said, "When you take a flower in your hand and really look at it, it's your world for the moment. I want to give that world to someone else."<sup>1</sup> I completely understood what she wanted to share through her artwork and wanted to share it as well. I loved the macrostyle of her work with flowers and I wanted to replicate it with my photography. Macrostyle takes people to a different level from what they normally perceive, and it shows them the deeper side of everyday sights. I think that people often are caught up in their own worlds and don't think to stop and enjoy the little things in life. Too often, all the details that make up someone's surroundings blend into the background and are overlooked as ordinary. Georgia O'Keeffe's work is aesthetically pleasing and visually striking, which is what I aimed for with my photograph. She transformed flowers, objects that busy humans usually do not pay attention to, into something of importance that demands attention. I wanted to accomplish what she had; I wanted make people stop, even if just for a brief second, and say, "Wow."

I tried to use the lighting in my photograph to my advantage, highlighting the different textures on the purple daisy and capturing the dewdrops sliding from its petals. The contrast in background colors and shapes causes a natural sort of framing in the piece, drawing the observer's eves to the focal point. Although Georgia O'Keeffe's pieces often feature two or three flowers together ("Purple Petunias" also has multiple flowers), I focused the camera on only one flower to emphasize it and accentuate the concept that even ordinary things can be extraordinary if you take a closer look at them. Nowadays, it is easy to get distracted with busy scheduled and technology (e.g., cell phones, computers, and social media), but we need to remember how to recognize the beauty that lies in the simplest things as well—for instance, a purple daisy. We rely on technology for everything from socializing to defining ourselves to learning new information. Although this sort of thing has the potential to be great, it also has the potential to be abused. I do not want people to forget that the entire world is not all in a screen. Technology is becoming embedded into everyday life and invading every facet of daily routines.

Years from now, how will an uncomplicated, non-electronic object such as a flower be able to stand up to some technology with which you can interact? I wanted to emphasize in my piece that even though something as simple as a flower may not be able to interact with people the way a cell phone does, it does interact in its own way by infusing its beauty into the environment and giving positive emotional influence to those who stop to appreciate it. With the detail in this photograph, I do not have any trouble believing that I can "give that world to someone else" for a moment.

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## **INSIGHTS**



This work is a collection of several of my experiences that I have compiled to portray a generally unknown aspect of life as a service dog user. I chose an unconventional style of writing for this piece. It is composed as a full narrative that flows as a stream of consciousness—with other narratives interrupting it-because I felt that this style of composition was most effective for highlighting a different perspective, my perspective, on a seemingly ordinary conversation. I am in a unique position, as someone who has not been blind all my life, to understand the experiences and feelings of people on both sides of this conversation, as I have been on both sides many times myself. The conversation depicted in this narrative represents, and is intended to be viewed as representative of the broader truth that it is easy to compartmentalize people into certain categories based on their physical appearances. As a visible figure in the community on account of my dog, I have experienced this compartmentalization, as I believe many disabled people do, to an extreme extent because my radical differences make it easy to place me into a defining category. Unfortunately for me, the category I am most often placed into is "dog."

#### "You have a beautiful dog," he says, and I turn my eyes

toward him. He is sitting three seats down from me on the other side of the aisle, but I know he is talking to me; no one else brings a dog onto the city bus.

"Thank you," I say politely, knowing exactly what is about to happen. I'd had this conversation countless times over

### Kaitlyn Kellermeyer

the last eight months, and I knew exactly what to expect-the sequence in which the questions would come, the way they would be asked, and the way my impromptu interviewer was hoping I'd answer them. This inevitable script played itself out several times daily for my viewing pleasure. It had become a soundtrack to my life, transposing its familiar melody over the tune of rattling city buses, noisy classrooms, and even flushing toilets.

"Is it a boy or a girl?" he asks, and I can almost hear the needle drop onto the record.

"He's a boy," I reply, thinking of the doctor at Beutel who had referred to my dog as "[my] boyfriend." That day I had gone to the clinic feeling sicker than I had felt since leaving home almost two years earlier. "I'm almost tempted not to treat you so I can see your beautiful boy again," she'd said as she wrote my prescription. I'd ignored the comment and thanked her for seeing me before heading out to my next class in the rain. The medicine didn't help, but I didn't go back.

"What's his name?" my interviewer asks.

"Lunar," I reply, my thoughts flashing to a similar conversation I'd had a few months earlier. I'd been asked this same question, among others, by a young man who'd seen me walking to class and who had decided to walk with me and inquire about my dog. Interestingly enough, I encountered this same young man a couple of weeks later on my way to the same class. Being totally blind, there was no way for me to have recognized him, but I didn't need to-he approached me again when he saw me, greeting me cheerily with "Hey, it's Lunar, right?"

The man sitting across from me interrupts my train of thought when he says, "I know you're not supposed to pet service dogs, but he sure is beautiful," and I brace myself inwardly. I think of how difficult it is to ask well-meaning, dog-loving people not to pet my service dog. I also think of all the people who have told me that it is almost torture for them to resist petting my dog, and I wonder if it ever occurs to them how strange that comment sounds to me. I want to shake my head at this thought, but instead I just nod and thank the man for his compliment.

"How old is he?" the man asks.

"Two and a half," I respond, leaning over and scooping my arm in front of Lunar's body to brace him as the bus turns sharply.

"Wow, he's a young one," the man remarks. It's a remark I'm accustomed to; I hear it regularly in one form or another, usually followed by "he's so well behaved." That's why you're not supposed to pet service dogs—so they stay

calm and behaved around people, I usually try to respond. I can't always get it out, and I often feel the fluttering anxiety that the other person is quietly petting my dog without me knowing. The truth of it is that there's so much more to it. No, you can't pet my dog because he's working. No, you can't pet my dog; he has to be totally focused on me while he's in his harness—my safety literally depends on it.

"How long have you had him?" the man inquires.

"About eight months," I respond.

"Oh. Did you have one before him?"

"Nope. I didn't need one." I tell him. What I will not tell him, I know, is that I didn't need one because, just over a year ago, I could see. It seems like a lifetime ago to me now, and part of me misses the anonymity of it. I try not to think about it too often anymore—the simple beauty of being able to walk into a room unnoticed, or of being spoken to only by people who genuinely care about some aspect of me as a person. The downside to being noticeable that most people don't understand is that you're constantly being singled out by everyone around you, when sometimes all you want is a place to belong.

## "What I will not tell him, I know, is that I didn't need one because, just over a year ago, I could see."

He does not take my bait and inquire about my past, but rather remains fixated on the dog. This is normal, though; it's what most people do. "He's such a good boy," the man croons, and I nod vaguely, pulling a dog treat out of the food pouch I carry on my hip and placing it to Lunar's nose. He gobbles it up happily as the bus slows down, and I hear "Last stop, Trigon," announced over the speakers.

My conversation partner has fallen into what I interpret as a contented silence, although I cannot see his face to be sure. I run through our conversation quickly in my head and figure that, at this point, he's probably done asking questions. I shift in my seat, adjust my backpack straps, and prepare to exit the bus as quickly as possible so as not to be in anyone's way. Lunar, sensing my anticipation, straightens up and turns his gaze expectantly toward the front doors of the bus.

It is then that he asks a question that catches me off guard. It almost seems to surprise him as well when he says it, and I can hear a distinct difference in the tone of his voice as the words spill out. It fills me with a bittersweet sadness when he says it, and I look toward him again. I can't imagine what he's thinking in this moment, but the tone of his voice makes me believe that I can guess. An eavesdropper with an untrained ear might have said the question sounded almost apologetic, but I'd heard people speak to me in this way enough times to be able to recognize the slight surprise and uncertainty that danced around the edges of his words. It's the tone of voice that people use only when they realize that something important has come to them as an afterthought.

"Oh, what's your name?" He asks, and I smile as the bus stops and I stand up.

"Kaitlyn," I say.

A few weeks later I happen to run into this same man on the bus again. After helping me find a seat, he asks me to remind him whether my dog's name is Luna or Lunar. We talk casually for the rest of the bus ride, but it doesn't take me long to realize that he's not addressing me by my name.

Through this account of my experiences, I hope to make you cognizant of your human tendency to quickly judge others by their appearances. My hope is that my story will bring awareness to the fact that interacting with others based on snap judgements can affect other people's perceptions of their defining characteristics in society. As students, professors, parents, and Americans we are accustomed to being asked certain questions that pertain to our respective compartments, including "what major are you?", "where do you work?", and so on. Although these questions are essential for getting to know others, this tendency to stereotype people can become harmful when the aspect of a person's life or appearance that is fixated on does not reflect that person as a whole. Most people desire to be cared about and valued as human beings, and I mean for this work to remind people that their actions are part of other people's experiences and consequently can shape other people's perception of their own value as human beings. When a person experiences frequent interactions with others that are based on one aspect of appearance or lifestyle, that person will tend, over time, to view that aspect of his or her life as socially valuable. Problems arise when this continual reinforcement of social value emphasizes only a few aspects of that person's life, because this can lead to the belief that other people value only those few characteristics. I felt like it was valuable for you, the reader, who may or may not have ever encountered a blind person with a service dog, to gain some insight into the firsthand feelings and thoughts of someone who lives her life as a blind service dog user. Choosing to work with a service animal puts a person in a unique circumstance and creates an enormous potential for the dog handler to feel as though society at large views his or her value as a person as resting primarily in the dog.

The larger purpose of this composition is to cause you to stop and think about the way you interact with different people and what effect those interactions might have. I wrote this piece after about eight months of personal experience and self-reflection as a blind guide dog user, and the inspiration for this piece came slowly as I experienced aspects of this new lifestyle.

## **CRITICAL THINKING:** THE FOUNDATION OF SCIENTIFIC WRITING

## **Bethany Bell and Megan Krail**

#### Introduction

In 1990, the National Science Foundation published a report highlighting the importance of science, technology, engineering, and mathematics (STEM) education and promoting scholarship in these fields.<sup>1</sup> Seeing the need for innovative thinkers in STEM fields, public K–12 schools are now pressured to prepare students for the demands of maintaining societal progress in these crucial areas. Recognizing the changes that need to take place in the public school system to better develop student scientific thinking led our research team to ask the following questions:

- What characterizes scientific thinking?
- Is knowing facts the equivalent of scientific thinking, or does the ability to understand science come from synthesizing information?

When students fully understand something, they can explain it in writing.<sup>2</sup> This promising avenue of analysis led our research team to consider writing as a way to measure critical thinking. We centered our focus on the process of monitoring one's own thinking, also known as metacognition, through science writing. Measuring scientific thought is complex, and a tool for evaluating scientific thought as displayed in student writing does not exist. To fill this gap, our team created a research-supported rubric that measures the critical-thinking processes of students as they write scientific texts. Our study asks whether different critical-thinking levels can be measured through the writing of high- and low-achieving science students. If we can identify these different levels of critical thinking, we can give teachers a tool to determine where student comprehension breaks down. Also, identifying the common trends of high-achieving students will help teachers determine thought processes to model and promote in the science classroom.

#### Previous Studies

As we designed our rubric and contemplated ways to measure critical thinking and metacognition, our team considered previous work to better understand how the mind functions while writing and thinking. Previous studies conducted in science writing have identified strong scientific thinkers as individuals who make connections and are highly aware of their thought processes.

Science educators are faced with the challenge of measuring critical thinking: how can a teacher monitor a process that takes place in the minds of the students? Conner suggests that the best way to solve this problem is to gain evidence of the thinking process through student writing. Her study shows that students with more advanced critical thinking skills naturally display better science writing skills.<sup>3</sup>

After examining student writing as an avenue for measuring critical thinking about science, our research team considered how to evaluate the critical-thinking process from student science writing. Bereiter and Scardamalia's concept of knowledge-telling versus knowledge-transforming writing can be used to identify strong science writing and scientific thought.<sup>2</sup> These science writing experts define knowledge-telling writing as using existing cognitive structures to report information. When engaging in knowledge-telling, a writer first creates a mental representation of the task or assignment at hand and then combines his or her content and discourse knowledge by making connections to experiences, background knowledge, given information, and so on, to complete that task. In knowledge-telling, students may list facts they know but fail to make connections between what they know and the problems they are given. When this crucial step of deep processing is missing, students do not doubt, consider, argue, explain, reason, or make a counterclaim about what is taking place in their minds.<sup>2</sup>

Knowledge-transforming writing, however, involves "going beyond normal linguistic endowments in order to . . . accomplish alone what is normally

accomplished only through social interaction."<sup>2</sup> That is, when knowledge is built through social interactions with more knowledgeable others, writing can help an individual organize, reformulate, and essentially transform his or her existing knowledge into new concepts.<sup>4</sup>

When students take their thinking further and transform their knowledge, they will display the argumentation, consideration,

construction, evaluation, and analysis in their writing that takes place in their minds. If this evidence is found, we can follow the mapping of student thinking that has been put into words. To determine where student science comprehension breaks down, teachers must identify whether students are merely describing the information they know or transforming the knowledge they have been given.

#### Rubric Development

Recognizing the need for a simple yet effective tool to grade student critical thinking, we created the Rubric for Evaluating Scientific Thought in Writing (REST-W; see Table 1). The rubric uses a 0–2 scale to score and evaluate student writing. A score of 2 indicates that the student followed the knowledge-transforming pattern of clearly showing deep processing, making a claim, and supplying an explanation. A score of 1 signifies that the student shared knowledge by listing facts without displaying a specific thought process. Finally, a score of 0 reflects that a student made no response or guessed. Also, student examples are given to help guide teachers in the scoring, along with descriptions from Bereiter and Scardamalia's seminal 1987 work that support each score description.<sup>2</sup>

Methods

The participants of the study were 18 sixth-grade students enrolled in a small private rural school in the southwestern United States. After receiving approval from the Texas A&M University Institutional Review Board, we collected parental permission slips for each participating student. To measure the levels of critical thinking skills across student performance, our team administered a combination of multiple-choice questions from two standardized science exams, the National Assessment of Educational Progress and the Trends in International Mathematics and Science Study. We included questions testing content knowledge ranging from grades 4–12. In addition to multiple-choice responses, the last three questions required students to explain their selections in writing.

We first scored the students's multiple choice answers to determine a class average. We then identified students who scored achieving students will at least 1 standard deviation above the mean as high-achieving and at least 1 standard deviation below

the mean as low-achieving. This approach resulted in 10 students included in the final analysis their response rather (see Table 2). Using the rubric we developed based on scholarly research in the science writing field, we measured these students's critical thinking through their written justifications to the science questions. After

scoring the students's performance on the standardized tests and measuring their written responses, we analyzed our findings.

#### **Results**

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After calculating the average score of 69.13% (SD = 21.69%) on the multiple-choice test, we compared the results of students who were 1 standard deviation above the mean and 1 standard deviation below the mean. Highachieving students scored between 88.24% and 94.12% correct with an average of 89.42% on the multiple-choice section of the test. By contrast, low-achieving students scored between 17.65% and 47.06%, averaging 38.23% correct. Eighty-percent of the time, high-achieving students scored a 2 on the REST-W. None of the high-achieving students scored a 0. At the opposite end of the spectrum, low-achieving students scored a 0 on the REST-W twothirds of the time, with 1 being the next most common score.

The trend found among high-achieving students was a score of 2 on the REST-W. Their writing showed deep processing, argumentation, and explanation of knowledge, thus leading to higher performance on the multiple-choice

#### Table 1. Rubric for Evaluating Scientific Thought in Writing (REST-W)

Score	DESCRIPTION	Student Examples	<b>Research Based Support</b>	
0	No response Unintelligible response A guess without further explanation	I guessed Guessed I just guessed	N/A	
1	Facts are listed without a supporting thought process Explanation suggests a thought process took place, but the exact process is unclear to the reader	It is b/ the yellow ball floated Because I learned heavy objects will sink, lighter objects float I chose this because I have learned this before and tested it myself before	This kind of writing would be classified as knowledge-telling writing, or writing existing knowledge to report information	
2	Deep processing is shown by including the specific thought process Argumentation is used to communicate the claim being made Knowledge is shared through explanation and counterclaims are made	I chose this answer because the less air inside an object, the less it will float and it makes sinse [sic] that if the red and green balls are more in mass inside then they have less of an air pocket than the yellow	This would constitute knowledge-transforming writing, or when students use writing to organize, reformulate, and essentially transform existing knowledge into new concepts	

#### Table 2. Participants's Scores and Descriptives

Student	Gender	Percent Correct	Short Answer 1	Short Answer 2	Short Answer 3
H1	М	94.12	2	2	2
H2	М	88.24	2	2	2
H3	М	88.24	1	2	1
H4	F	88.24	2	2	2
H5	М	88.24	2	2	1
L1	F	47.06	1	2	0
L2	М	47.06	1	1	2
L3	М	47.06	0	0	0
L4	М	35.29	0	0	0
L5	F	17.65	0	0	0
Note. IDs for high-achieving students begin with an H. IDs for low-students begin with an L.					

test. For instance, H1, who scored 94.12% on the multiplechoice test, justified the question of why one ball might sink while the other ball floats through deep processing: "If the yellow ball's mass is less than water and the red and green balls are greater, since they are exposed to the same gravitatial forces, that means the yellow ball is lighter." H2 demonstrates explanation skills through his short answer: "I chose this answer because to find which fertalizer grows plants better, you have to have them in the same place with multiple of the same plant for each fertalizer in case of one plant is in bad shape." H3 also gives an example of effective argumentation: "because, the more similar the environment the better you can analyze the result."

For the low-achieving students, a score of 0 was most common. A trend we found in the study was that many low-

achieving students responded to the reflective questions with "I just guessed" or the space was left blank. The students who scored ones on the REST-W often showed knowledge telling but failed to reach the knowledgetransforming stage of writing. For instance, L1 attempted to describe her thought process as follows: "The yellow ball is lighter than the red and the green balls. Because lighter floats and heavyer [sic] sinks." The lack of critical thinking demonstrated by low-achieving students often resulted in a lack of ability to transform knowledge as reflected in poor scores on the multiple-choice standardized exam.

#### Conclusion

This study allowed our team to determine a relationship between high-achieving science students's testing scores and the thought processes displayed in their writing. When given a question to ponder, high-achieving students will activate their critical thinking skills to formulate their response rather than merely guess. Using the REST-W, teachers can now evaluate student science writing to determine where critical thinking stops for each student. With this knowledge, teachers can begin to focus on how to teach low-achieving students critical thinking skills to facilitate academic success.

To make this change, teachers must focus on asking questions that guide students to engage metacognitively in the science classroom to help promote better scientific thinking in students. When students are tempted to only list what they know and stop before making connections, teachers must follow through by asking further critical thinking questions that require students to deeply process the information. For instance, rather than simply teach the steps in plant photosynthesis, the teacher could present students with two plants, one thriving and one dying. The teacher could then ask students to hypothesize what caused these differences and then explicitly connect student responses to the science content. Such teaching practice will guide students to make the connections necessary for deep scientific thought.

Continuing this vein of research, our team is exploring how the writing of low-achieving students affects achievement in science class. Future research must seek intervention strategies that can promote critical thinking skills in science and overall academic success.

One limitation of this study was the sample size. Although we did identify outlying scores to select the high- and low-achieving students, the overall pool was small. Also, we examined the performance of only one grade level. Most likely, the abilities of students will continue to mature as they complete middle school and high school, and we may see different results with different grade levels. Future research should examine larger samples of more heterogeneous students to see whether the patterns observed here hold true.

#### Acknowledgments

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## A Crumbling Campus

Julia Cisneros, Aida Guhlin, Jeanette Flores

#### Introduction

On any given day at Texas A&M University, prospective students can be seen on campus tours, learning about Texas A&M traditions and treasured campus locations. These areas are often picturesque: the Century Tree's branches gently

bowing over the sidewalk or Sully's boots shining among the lucky pennies. These locations often inspire a sense of community and awe at the strong history of Texas A&M.

But what happens when the students leave the tour to explore on their own? Will those feelings remain when they

trip over deep dips in the sidewalks and soak their feet in a puddle? What about when they notice the crumbling exterior of a building that might house most of their classes? Many locations on campus are dilapidated, but how many exist? Can prospective students see them from the campus tour? How many of the overall broken areas go unseen and thus left in disrepair? In our research, we asked how many areas of main campus that appear to be falling apart are also visible to visitors and prospective students.

#### Background

To most of the population, GPS is a tool for personal navigation. However, handheld GPS devices can also be used to create real-world data—points in the real world that can be taken and displayed spatially. Inspired by the abilities of GPS, we sought to record all main campus locations broken enough to notice, usually by their ability to impede travel. When students must encounter entire pathways rendered unnavigable due to dips flooded by rain, something is wrong. We sought to record these instances that hindered travel and objectively discover just how many of these locations existed and where.

Spatial analysis of these locations also goes beyond the basic mapping. Although knowing an object's location is helpful, examining the spatial landscape for potential patterns moves past simply knowing where problem sites are. Spatial patterns develop from all kinds of human activities: politics, financial restraints, and opinions. Determining whether the points of neglect follow a spatial pattern can yield hard data to help answer important questions such as whether the campus is truly handicap accessible. For example, a location may have the facilities to be handicap accessible and yet not be



#### Methods

To collect our data, we split the main campus into three areas:

- 1. The south side of campus from the Liberal Arts and Humanities (LAAH) building to Coke Street and Mosher Street to Bizzell Street.
- 2. The west side of campus from Asbury and Lamar Street to Wellborn Road.
- 3. The north side of campus from LAAH to University Drive and Asbury Street to Bizzell Street.

We examined the campus for visibly broken, cracked, or uneven (sunken) sidewalks, paths, or crumbling building exteriors. Other acceptable data points included potholes, broken windows, walls covered with graffiti, and other signs of deterioration. After collecting the data, we used ArcMap software to produce a map from the GPS data. This map allows us to see the points of disrepair throughout main campus and consider any spatial patterns that may exist (Figure 1). We also created created a density map (Figure 2), which shows areas with the most damaged sites, and a map that displays recommended path for Texas A&M tours, that we used to determine what points were visible from that path (Figure 3).

To understand which damaged sites could be easily seen while on a campus tour, we needed to know what the elevations of the damaged sites in relation to the path of the Texas

"When students must encounter entire pathways rendered unnavigable due to dips flooded by rain, something is wrong."



**Figure 1.** Individual sites of disrepair on Texas A&M main campus. Red dots show the location of 269 sites (because of scale, not all points are visible).



**Figure 2.** Density of the 269 points found on main campus. Darkness of the pink splotches indicates the number of damaged sites at that location.

A&M tour. We used light detection and ranging (LIDAR) data (Figure 4) acquired from the City of College Station to obtain high-resolution digital elevation data. LIDAR is typically used to measure elevation, which is the type of data we needed. To move from elevation data to identifying which damaged sites could be viewed from the tour path, we needed to perform a viewshed analysis. We used the LIDAR data to create a triangulated irregular network (TIN). The TIN partitions our data into triangles that fit over the map



Figure 3. Recommended path for Texas A&M tours.

of damaged sites. Combining the TIN with our damage map allowed us to do a viewshed analysis. The viewshed analyses told us which damaged sites could be viewed (Figure 5) and which could not be viewed because of the area's elevation.

#### Results

After analysis of the data, we concluded that our original hypothesis was correct: the tour did not align with most of the decrepit areas on campus. The tour takes prospective students along a pristine path that avoids older parts of campus (such as the north side, where the Fowler-Hughes-Keathley complex, Walton, and other older dorms are located).

Besides simply letting us view our data on the map to support our conclusion, the viewshed analysis was one of the most efficient and effective pieces of data to support our hypothesis. In Figure 5, one readily sees how only 42 of the 269 points identified were seen on the tour path. Furthermore, those sites were minimally damaged (nothing like the huge cracks and uplifted bricks on the campus's north side). The density map (Figure 1) also shows the densest collection of points around the dorms mentioned earlier, and the densest collection of points appears as the darkest on the map.

The farthest distance from which the points could be seen from the tour path was a point near the Computing Services Annex from the path near the library, approximately 0.3 mile. Six easily viewable points were extremely close to or on the path, which means they couldn't be more than a few feet away from the path.

#### Conclusion

The sheer number of points found on campus shows that much of the campus could use some renovations to improve sidewalks, buildings, and other often-used areas. The fact that so few of the points are visible from the path suggests that our campus is being misrepresented when prospective students take the tour. That the points also correspond to the oldest area of campus suggests that the oldest part of campus is being neglected, instead of well-kept. Although of course new buildings are important, as the campus expands to encompass more fields and meet the desires of students, maintaining the rich history these buildings embody is necessary. Besides the rich history of the buildings, the campus is the domain of pedestrians. Impeded student travel through campus to classes can cause a barrier to education. Worse, we are concerned that if students have a hard time navigating campus on foot, what about those with physical impediments? Do those who must navigate in wheelchairs or even just crutches have a harder time getting around on campus, especially in unfavorable weather conditions? With our data and analysis, we hope that these questions and more can be given due consideration.

The spatial trends of the points across campus were as expected, but the information we gathered could be useful in the future. For example, if the campus administration was thinking of creating a new tour, our information could help determine what parts of campus to avoid or repair. Or the data we gathered could support proposals to renovate parts of campus. Regardless, our data can serve those interested in clarifying exactly where renovations are most needed.

#### **Future Work**

Although we were satisfied with seeing our hypothesis proven, some areas of our project could have been improved. For example, the construction sites on campus could have also been catalogued and then used in our analysis as well. We would like to catalogue the areas of West Campus that are in disrepair and see whether their numbers are also higher around older buildings. This endeavor could also be interesting because West Campus has a clearer delineation of old and new buildings. Another interesting statistical analysis might have been to record the relative ages of the buildings on main campus. We then could look to see whether an uptick occurred in areas of disrepair near the oldest buildings on campus and determine the causes. Finally, another interesting statistical analysis might be to consider where damaged sidewalks are in relation to the amount of pedestrian traffic. Such a study might find that areas with more pedestrian traffic would have more disrepair.



**Figure 4.** LIDAR data help us create a model to determine points visible from the path.



**Figure 5.** Points of disrepair visible from the tour. Yellow dots indicate the 42 sites visible from the tour path.
# NEUROSTEROIDS HAVE GREAT POTENTIAL IN THE TREATMENT OF EPILEPSY

# Iyan Younus

### Introduction

E pilepsy is one of the most common neurological disorders, affecting nearly 65 million people worldwide and approximately one in every 100 Americans. Epilepsy is characterized by recurring spontaneous seizures that can cause unconscious sensations and uncontrollable behaviors. These symptoms are associated with abnormal neuronal activity in the brain and result in staring, twitching, and a loss of motor control. The current theory surrounding the pathogenesis of epilepsy postulates that epilepsy develops after an initial event such as traumatic brain injury, stroke, brain infections, or exposure to toxic nerve agents.

The development of epilepsy is a function of time, with a latent period after injury when no sign of seizures is apparent, followed by the rapid onset of seizure activity. Typically, epilepsy is not diagnosed until multiple seizures are observed. Sir William Gowers, regarded as the father of modern epileptology, proposed as early as 1881 that "seizures beget seizures."<sup>1</sup> This idea has served as the framework behind paradigms used to model epilepsy ever since. Despite more than 130 years since Sir Gowers's claim, science has been unable to translate any discoveries into long-term preventive therapy, and thus no cure for epilepsy exists to this day.

Current treatments for epilepsy suppress the onset of

Neurosteroids offer an unprecedented opportunity to treat the complex physiological mechanisms underlying the development and persistence of epilepsy. Neurosteroids are produced in the brain from hormone precursors (such as progesterone) or directly from cholesterol. Neurosteroids produce rapid effects on neuronal excitability through pathways that AEDs do not usually affect. Neurosteroids owe their potency to their direct interaction with receptors for gamma-aminobutyric acid (GABA), a major inhibitory neurotransmitter in the central nervous system.<sup>3</sup> Upon binding to GABA, receptors, neurosteroids activate chloride channels in the neuronal cell membrane, thereby hyperpolarizing the membrane and reducing neurons's rate of firing action potentials. Through this mechanism, neurosteroids exert antiseizure effects and lower seizure incidence and severity. Neurosteroids are potent antiseizure agents and have great potential in the treatment of epilepsy. Therefore, continued investigation into neurosteroids and their role in seizure susceptibility may lead to breakthroughs in treating patients with epilepsy.

The main objective of this study was to investigate how neurosteroid analogues affect seizure activity in an animal model of epilepsy. If neurosteroids reduce seizure incidence in our preclinical animal model, further clinical trials may be warranted to explore their efficacy in humans with epilepsy.

seizures in people with epilepsy but do not protect from the possibility of developing "... science has been unable to translate any discoveries into long-term preventative therapy..."

epilepsy in patients at risk. These treatments include antiepileptic drugs (AEDs) such as diazepam, lorazepam, and midazolam.<sup>2</sup> Although AEDs have existed for decades, about one-third of people with epilepsy do not respond to these treatments. AEDs also have several side effects due to their sedative properties. These effects interfere with normal brain function in some users. Therefore, novel pharmaceutical interventions are needed for rapid and effective treatment of epilepsy.

### **Materials and Methods**

To determine how neurosteroids affect seizure susceptibility, we used the mouse hippocampal kindling model, a model of human complex partial seizures.<sup>4</sup> Kindling is the repetition of electrical stimuli to the brain that evokes a fully kindled state, in which an animal can be electrically stimulated to have a seizure. Each mouse was implanted with an electrode (Figure 1) and



Figure 1. An implanted bipolar kindling electrode in the hippocampus region of the brain, which allows for simultaneous electrical stimulation and recording of after-discharge activity.

monitored during a recovery period of 7-10 days. Upon stimulation. mice became unconscious and remained so for the duration of the seizure.

We delivered an electrical pulse to the brain and recorded the resulting brain activity (Figure 2). Figure 3 shows the typical progression of

seizures upon subsequent stimulations. We also evaluated seizure activity visually after each stimulation according to criteria ranging from no response (stage 0) to falling (stage 5).

We used a daily electrical stimulus to develop a kindled state (Figure 4). Once the mice consistently exhibited stage 5 seizures with stimulation, we used them for our studies. Once an animal has been fully kindled, the heightened response to the stimulus is permanent and seizures occur upon stimulation even after several months.<sup>5</sup> To examine the ability of neurosteroids and their ability to suppress seizures, we injected fully kindled animals with the neurosteroid before stimulation, recording the seizure stage

to test our hypothesis that treatment with neurosteroids

and duration at multiple time "... neurosteroids will be a giant leap receptors and their potency to suppress forward in treating epileptic seizures." potency to suppress

would measurably decrease seizures severity.

## **Results**

The results of our study strongly support the ability of neurosteroids and their analogues to suppress the severity of seizures. Our seizure activity profiles show promising evidence that allopregnanolone-like neurosteroids are powerful antiseizure agents. Allopregnanolone is a prototypical neurosteroid that exhibits neuroprotective effects against seizures and suppressed behavioral and electrographic seizures in relation to the dose (Figure 5).

The suppression of seizure activity with Allopregnanolone was time dependent, with the lowest incidence and seizure severity from 0.25 h to 1 h after treatment (Figure 6). The recurrence of stage 5 seizures was seen by 4 h after treatment. This finding serves as evidence that the neuroprotective action of neurosteroids occurs only within a certain window of time, possibly



Figure 2. The kindling system.

because of the body's metabolization of the drug.

## Conclusions

This study's findings offer compelling evidence for the use of neurosteroids as a therapeutic approach to treat seizures in patients suffering from clinical epilepsy. New information is also quickly emerging on neurosteroid

interaction with GABA, seizures and modulate

epileptogenesis, the process by which the brain becomes epileptic. On the basis of these results, researchers are developing novel therapeutic approaches and testing them in human clinical trials. Among the neurosteroids tested, ganaxolone, a synthetic analog of allopregnanolone, is the only one that has been tested in human clinical trials so far.<sup>6,7</sup> Neurosteroids, notably progesterone derivatives such as allopregnanolone, have many advantages over current treatments for epilepsy. Neurosteroids do not produce the tolerance that appears to occur with extended use of AEDs, and new biochemical techniques allow



Figure 3. The typical progression of electrographic after-discharge (AD) activity during the kindling stimulation paradigm in mice. Upon later stimulations, an increase in peak intensity and AD duration correlates with seizure severity.



**Figure 4.** Progression of hippocampus kindling development in mice. The fully kindled state is exhibited in mice after approximately 15–20 days of stimulation.



**Figure 5.** Dose-dependent properties of the neurosteroid AP in the hippocampal kindling model.



**Figure 6.** Time-dependent action of the neurosteroid AP in the hippocampal kindling model.

researchers to produce longer-lasting bioavailable forms for clinical application.<sup>8</sup> Thus, our data suggest that neurosteroids will be a giant leap forward in treating epileptic seizures.

## Acknowledgments

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# **CLOUDY WITH A CHANCE OF HAZE:** How Aerosols impact cloud formation

# **Megan McKeown**

### Introduction

Take a deep breath. Did it occur to you that you were inhaling anything more than air? In reality, minuscule particles just lodged themselves into your lungs. These particles may have originated from the car that just drove past or even from a dust storm that occurred in the Great Sand Dunes of Colorado a few days ago. These particles suspended in the atmosphere are called aerosols, and they are an obstacle in the prediction of future climate change, which scientists are working to overcome.

Aerosols are submicron-sized particles with diameters of about 1/30<sup>th</sup> the size of a human hair.<sup>1</sup> They can remain airborne for extended periods of time due to their light weight. Aerosols impact our climate in two distinct ways. The first, known as the direct effect, is when aerosols suspended in a haze both scatter and absorb sunlight (Figure 1).<sup>2</sup> The second, referred to as the indirect effect, occurs when aerosols induce the formation of clouds and change how clouds reflect and absorb sunlight.<sup>2</sup> Both of these effects alter the amount of sunlight received at the Earth's surface. This alteration disturbs the Earth's energy budget, which is a delicate balance between incoming solar radiation from the Sun and outgoing radiation from the Earth.<sup>3</sup> Aerosols's variable effects on the atmosphere complicate scientists's ability to make confident statements about climate change.<sup>4</sup> In order to further understand how aerosols affect the climate more research needs to be conducted on their physical and chemical properties.

### Background

Aerosols originate from a variety of both natural and human sources. Natural sources of aerosols include volcanoes, forest fires, ocean spray, and dust storms. Human activities, such as burning of fossil fuels, driving of cars, and incinerating

waste, also lead to increased emissions of aerosols.<sup>4</sup> With the rise in industrialization across the globe, human-sourced aerosols have reached unprecedented levels in the atmosphere. Once emitted, aerosols can remain suspended in the air from hours to years. Aerosols that are emitted directly from a source are known as primary aerosols; however, chemical reactions that occur in the atmosphere can lead to the creation of new aerosols referred to as secondary aerosols.<sup>5</sup> The cycle of chemical reactions in the atmosphere can prolong the suspension of secondary aerosols in the air and increase the concentration of aerosols in certain regions.

In regions with high concentrations of aerosols, cloud formation can be fundamentally altered. Clouds form when air becomes saturated so that water vapor begins to condense onto available surfaces.<sup>3</sup> Suspended aerosols can serve as these available



surfaces by acting as seeds, known as cloud condensation nuclei (CCN), for clouds to grow upon. When enough water vapor condenses onto CCN particles, a visible cloud forms. The coverage, brightness, precipitation, and lifetime of clouds are changed in aerosol-polluted clouds.<sup>3</sup> With an increased amount of surfaces for clouds to condense onto. these clouds can cover greater areas. Furthermore, aerosols alter the optical properties of clouds to make them more reflective, and

Figure 1. Aerosols impact the climate through two mechanisms: the direct effect (left) and the indirect effect (right).

# "With the rise in industrialization across the globe, human-sourced aerosols have reached unprecedented levels in the atmosphere."

thus appear brighter. Although the concentration of aerosols is increasing, the amount of available moisture in the atmosphere remains unchanged. This means that less water is able to condense onto each CCN particle and that more cloud droplets are too light to fall to the ground as rain droplets.<sup>6</sup> Since less moisture is able to fall out, the lifetime of clouds is increased. All of these resulting effects further enhance aerosols's ability to block sunlight and lead to a net cooling effect at the surface.

The capacity at which an aerosol may act as CCN and induce cloud formation depends on its physical and chemical characteristics. This study focuses on how changing the chemical composition of aerosols from neutral to acidic pH levels influences their ability to act as CCN. A specific type of secondary aerosol, called aminium carboxvlate, was synthetically created, and the growth was studied in humidified environments. The growth of aerosols is represented by their hygroscopicity, which is a particle's ability to absorb water. Very hygroscopic aerosols readily uptake water and grow to large diameters. The larger diameter a particle has, the greater its ability to serve as CCN and induce cloud formation. Comparisons between the hygroscopicity of neutral and acidic aminium carboxylate aerosols were used to make conclusions on their ability to act as CCN.

### Methodology

In this study, four different organic acids: oxalic, succinic, p-toluic,





and cis-pinonic were separately dissolved and mixed with the base, dimethylamine. This acid base combination leads to the creation of a salt known as aminium carboxylate salt, which represents the chemical composition of a common type of organic aerosol found in the atmosphere. The first set of solutions were dissolved with equal amounts of acid and base to create neutral solutions with a 1:1 acid to base ratio. The second set of solutions were dissolved with excess amounts of acid to create acidic solutions of 4.1 acid to base ratios.

Once the liquid solutions were prepared, they were subjected to an atomizer. The atomizer converted the liquid solutions into a continuous spray of submicron sized aerosols. The aerosols were then introduced into a Tandem Differential Mobility Analyzer (TDMA). Initially, the TDMA selected particles of a certain diameter range, specifically in the

> range of 46–151 nanometers. Having been selected for their size, the particles were then released into a controlled humidified chamber. The relative humidity (RH) in the chamber increased from 10–90% by increments of 10% for each experimental run. After being subjected to the humid environment, the change in particle size was then measured. The hygroscopic growth, which is the ratio of particles's final size to their initial size, was then calculated for each solution.<sup>5</sup>

### Results

The calculated hygroscopic growths were used to generate hummidograms for each solution(Figure 2). These plots show the change in hygroscopic growth with increasing RH values. Neutral and acidic compositions of the same solution were displayed on the same graph in order to make comparisons of their growth. In addition to the data collected from this study, the hygroscopic growth values of pure oxalic acid and pure succinic acid, as measured by Prenni et al. (2001) and Prenni et al. (2003), were compared.<sup>7.8</sup>

The hummidograms display a positive trend of increasing hygroscopic growth with increasing RH in all cases. This indicates that all the solutions absorb greater amounts of water at higher humidities. The oxalic acid:dimethylamine solutions exhibit the greatest growth with maximum hygroscopic growth values of 2.20 for neutral solutions and 1.95 for acidic solutions. The other three mixtures have similar hygroscopic growth values for neutral solutions, ranging from 1.70-1.75. The acidic solution of cis-pinonic acid:dimethylamine has the lowest hygroscopic growth value of 1.25, while p-toluic acid:dimethylamine and succinic acid:dimethylamine have values of 1.62 and 1.66, respectively.

Overall, neutral solutions for each acid to base mixture experienced greater growth than of acidic solutions. These results indicate that the presence of additional acid in a solution inhibits a particle's ability to absorb water. This is further supported by the findings of Prenni et al. (2001) and Prenni et al. (2003).<sup>7,8</sup> From these studies, the maximum hygroscopic growth of pure oxalic acid was 1.45, while succinic acid exhibited minimal growth with a value of 1.01. Both of these values are significantly lower than those of the solutions in this study because pure organic acids do not have the ability to absorb significant amounts of water. The results also show that the addition of dimethylamine to solutions creates highly hygroscopic aerosols. In conclusion, the presence of organic acids in the chemical composition of an aerosol particle limits its ability to intake water, but formation of the aminium carboxylate salts considerably enhances aerosol hygroscopicity.

### Conclusion

Data from the experimental study shows that aerosols of neutral 1:1 acid to base ratios are more hygroscopic than acidic ones with a 4:1 acid to base ratio. Furthermore, aerosols of oxalic and succinic acids mixed with dimethylamine are more hygroscopic than their pure acid components. This conclusion further validates the result that organic acids in an aerosol's chemical composition absorb only limited amounts of water, but the formation of organic salts makes aerosols more hygroscopic. The more hygroscopic an aerosol is, the greater its ability to activate as CCN and lead

# "By understanding how . . . aerosols can impact cloud formation . . . better predictions in the alteration of the climate may be made."

to cloud formation. The results from this study prove that aerosols's ability to act as CCN is dependent on their chemical composition. The chemical composition of aerosols depends on the source of origin and can vary from around the world. By understanding how different compositions of aerosols can impact cloud formation and alter the amount of solar radiation received by Earth's surface, better predictions in the alteration of the climate may be made.

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# **Smartphone Telemetry** A New Technology to Keep Track of Your Heart

Abdulla Baobeid and Faiyadh Shahid

### Introduction

Cardiovascular diseases (CVDs) are a major cause of death on a global scale. According to the World Health Organization, cardiovascular diseases account for more than 30% of deaths each year.<sup>1</sup> As a result, CVDs are also responsible for a large share of national health budgets. Treatment of CVDs not only results in high financial costs but also increases pressure on a limited number of welltrained cardiologists.<sup>2</sup> These challenges make automation of medical procedures an interesting development area for biomedical engineers.

The focus of this project is to present an integrated application for analyzing electrocardiography (ECG) signals, recordings of the electrical activity of the heart that cardiologists use to diagnose and monitor patients to warn patients about impending heart attacks. ECGs are usually analyzed by cardiologists; this causes ECG data to pile up on the shoulders of these specialists. To solve this issue,

our project aims to develop a portable and inexpensive system that detects cardiovascular abnormalities remotely. The system consists mainly of a smartphone application and a device called the microcontroller that collects ECG data.

### Background

Electrocardiography is the recording of the electrical activity of the heart. The technique can reveal information about the heart's condition. In this project, ECGs are used to detect heart attacks. ECGs are collected by noninvasive sensors called electrodes. To collect the ECG signals, electrodes are attached to a patient's body. A 10-electrode system is advantageous because it offers even more detailed information about heart activity than a fiveelectrode system. However, five-electrode systems are more comfortable for users and require less computational power from the smartphone.

The ECG waveform is characterized primarily by a series of deflections in an electrocardiogram that represent the electrical activity. Critical points named Q, R, and S, and other segments known as the PR interval, PR segment, ST segment, and QT interval (Figure 1) are commonly used to evaluate heart performance.<sup>3</sup> By analyzing the

"... our project aims to develop a portable and inexpensive system that detects cardiovascular abnormalities remotely."



Figure 1. Various segments of a normal ECG waveform.

shape, frequency, and amplitude of the points included in these segments, one can extract information about heart conditions.

## **Materials and Methods**

Figure 2 summarizes the method of detecting heart attacks by using ECG signals. The user connects nonadhesive electrodes to his or her body, using either a five- or 10-electrode-based ECG system. The signals obtained from the electrodes are filtered, amplified, and collected in a microcontroller. The microcontroller then sends the data to a smartphone application via Bluetooth. The ECG signal is sent from the smartphone to a Web server using either a cellular or a wireless connection. The data are securely processed and analyzed in the Web server using the algorithms developed by the previous team.<sup>4</sup> The results of analysis are then sent back to the smartphone application, which informs the user whether he or she is likely to have a heart attack. Our team developed a smartphone application to collect, process and communicate data.<sup>5</sup> The application was developed using Android Java and can run on various versions of Android. In the smartphone application, users can create their own account and keep track of their cardiovascular status. The data received from the microcontroller via Bluetooth are saved in the memory of the phone as a text file, which is remotely sent to the Web server to be processed.

We developed a Web server by using Python programming language and PHP scripting.<sup>5</sup> The ECG signals were analyzed using two algorithms developed by the team. The first algorithm detected various critical points on ECG waveform (Figure 1). Based on these points, a second algorithm was developed that detects possibility of the user having a heart attack. Both algorithms have been developed for 10- and five-electrode ECG system. These algorithms were developed using MATLAB software.

## Results

Our previous team developed the first algorithm for the 10-electrode ECG system.<sup>6</sup> The algorithm was tested on 40 patients: 20 with a documented history of heart attacks and 20 healthy subjects. These 40 patients were randomly selected from data on 290 subjects in the PTB diagnostic ECG database.<sup>7</sup> We observed that about 98.5% of the overall data was accurate. As a continuation of the project, the current team worked on the five-electrode ECG system based on the same algorithm used for the 10-electrode ECG system. The results were equivalent to those of the 10-electrode ECG system, as expected.

The second algorithm has been tested on the same data set for the case of 10 electrodes. With high accuracy, the algorithm detected whether the patient is at risk for heart attack. The team is working on developing the algorithm for the five-electrode ECG system so that the user can be provided with more comfort.



Figure 2. Block diagram of the system.

The data were successfully collected using a microcontroller selected primarily because of its higher clock speed and resolution. The data were sent from the microcontroller to the smartphone by using an HC-05 Bluetooth module. After the data were sent via the Bluetooth module, the real-time ECG signal was displayed on the smartphone application.<sup>6</sup> Once in the application, the user was given the option of zooming and scrolling into the ECG plot and saving the data files, if desired.

# "Every unhealthy heart has a cost to us all."

## Conclusion

Every unhealthy heart has a cost to us all. To those that suffer, it can cost everything. With the implementation of our telemetry system, cardiovascular abnormalities can be detected much more efficiently. Using the real-timeanalyzed ECG waveforms, the integrated system can be used to give the user early warning of cardiac risk, thus saving valuable time and effort in the patient's treatment. Along with that, this system will be efficient in terms of cybersecurity, cost management, and reliability. This experiment is only the beginning of exploring the potential of using microcontrollers and smartphones to observe CVDs. We are working to develop algorithms compatible with the more-comfortable five-electrode systems. As we continue our efforts, we hope to ultimately decrease deaths by CVDs.

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# **DOES MENTAL PRACTICE REDUCE** FALL RISK AMONG THE ELDERLY?

# **Ashley Fox**

### Introduction

### Implications of Falling in the Elderly

In the next 17 seconds, an older adult will be treated for fall-related injuries, and in the next 30 minutes, an older adult will die from fall-related injuries.<sup>1</sup> The Centers for Disease Control and Prevention states, "one out of three older adults (those aged 65 or older) fall each year." Unfortunately, it doesn't end there. In fact, the risk of falling continues to increase the older one gets, and over half of elderly adults aged 80 years fall annually (www.cdc. gov/homeandrecreationalsafety/falls/adultfalls.html). Even though these statistics are disturbing, the actual rate of falling occurrences is even greater, due to many incidents not being reported. Falls contribute to the highest number of unintentional injuries experienced by the elderly aged 65 years and older (www.cdc.gov/homeandrecreationalsafety/ falls/adultfalls.html). Clearly, falling has significant implications for quality of life in our aging population.

### Motor Planning and Reaching in Relation to Falls among the Elderly

Motor planning is used to estimate whether an object is reachable from one's current position. Research findings indicate that mental representation for action planning becomes less accurate and effective as one ages.<sup>2</sup> In other words, an elderly person's intentions do not match his or her capabilities. Others report that the elderly experience significant difficulties with the ability to mentally plan

and simulate simple and complex, sequential whole-body movements such as walking.<sup>3,4</sup> Taken together, these reports suggest that weak motor planning can prevent a person from determining actions his or her body needs in order to perform a motor task correctly and safely. If we apply these concepts to reaching, a simple "incorrectly" planned reach action (such as

over- or underestimation) by an elderly adult would result in more difficulty in maintaining postural control and an unrecoverable shift in center of balance, resulting in a fall.

In support of a disconnect between intended reaching actions and actual reaching movements, Gabbard and colleagues<sup>5</sup> and Noel and colleagues<sup>6</sup> reported that overestimation of action capabilities in the context of reaching was a common observation among older adults. Both studies also noted how overestimation of actions, which could be considered a risky (planned and/ or executed) movement, could increase the chance of a



Figure 1. An elderly person reaching, an activity that can involve incorrect shifting of body weight far from one's base of support, and therefore a potential for fall risk. Reproduced with permission from The Foundation for a Better Life, "Top Shelf" PSA © 2015.

fall. Furthermore, a recent review study that looked at the circumstances of falls in elderly people determined that incorrect transfer or shift of bodyweight was the most frequent cause of falling (41%).<sup>1</sup> Incorrect transfer or shift of body weight is defined as "self-induced shifting of

"... the elderly experience significant difficulties with the ability to mentally plan and simulate simple and complex, sequential (Figure 1). whole-body movements . . . "

bodyweight, causing the center of gravity to move outside the base of support" with the "imbalance [as an] internal rather than external (like a slip, trip, or stumble) [factor]."<sup>1</sup> A specific example of an internal factor provided by the study is leaning too far from one's base of support

### Motor Imagery Training

Motor imagery, a form of mental

representation, is the process of mentally visualizing what a movement feels like, instead of visualizing what a movement looks like. Most motor programming theories support the view that motor imagery is an extremely important component of effectively planning out and predicting actions.<sup>7</sup> Motor imagery is a rehearsal of movements from an internal, or first-person, perspective without any body movement taking place. Since reach estimation is based largely on how one perceives what one's body can do, motor imagery can help facilitate action planning regarding reaching. Using motor imagery, several questions will be answered, including "can I reach the

object while sitting, or do I need to stand?" and "if I reach for that object, could I lose my balance and fall?" Such questions are common among everyday action processing, regardless of whether one realizes it.

Ultimately, motor imagery is comparable to mental representation and motor planning of movements. Studies have shown a high association between real and simulated movements, and motor imagery practice has been supported as effective in regaining motor planning and control.<sup>7</sup> These studies commonly suggest that motor imagery training aids motor learning processes and improves motor performance. In a study of the effectiveness of motor imagery practice, Guttman and colleagues<sup>8</sup> found that motor imagery practice had a positive effect on actual action execution. All in all, motor imagery training has been documented as an effective training and therapeutic tool.

## General Strategies and Recommendations for a Motor Imagery Training Program

Gabbard and Fox<sup>7</sup> suggest the following strategies for designing a motor imagery training program to improve motor representation action planning:

- *Clear and effective script of instructions.* A specific script of instructions needs to be used for the training detailing thought processes and considerations for the participants.
- *Goal setting*. Goal setting is good practice when trying to accomplish a specific task and could positively affect performance.
- *First-person internalizing*. Focusing on performing the action from within oneself, which includes considering and understanding one's own capabilities and possible consequences of movement.
- *Concentration on the effectors*. Focusing on the specific body parts that are performing the action.
- *Focus on visual cues (target/objective/goal).* Concentrate on the final result (the target) of the intended action.
- *Reinforcement on kinesthetically feeling execution of movement.* Really focus on "feeling" oneself, instead of "seeing" oneself perform the movement. Doing so promotes effective mental representation.
- Combine physiotherapy (physical practice) with mental practice. This approach involves having the person actually perform the action, not just mentally represent the action. Doing so allows a person to gain a better understanding of his or her capabilities and possibly allows a person to experience potential consequences of an action.
- *Progress from simple to complex.* To build a foundation and have continued improvement and variety in situations.
- *Practice 15–60 minutes, three times per week, for 4 weeks.* This is the time frame commonly suggested and used for many motor training programs regarding other studies.

## Intent of the Study

Being able to effectively plan and estimate reach has both scientific and real-world applications. Research findings tell us the elderly lack efficient action planning and one of the most common reasons for falls is incorrect transfer or shift of bodyweight, such as leaning too far from one's base of support.<sup>1</sup> In other words, many falls in the elderly can be directly linked to reaching. Furthermore, a motor imagery training program can improve motor planning and reduce fall risk.<sup>2</sup>

### Study Objectives

This study determines whether a newly created motor imagery training program will improve:

- Overall reach estimation;
- Reach estimation in three conditions (seated, standing-two-feet, standing-one-foot); or
- Reach estimation between different age groups (i.e., young-old, aged 65–73 years, and older-old, aged 74–81 years).

## **Materials and Methods**

### Participants

A total of 23 adults aged 65–81 years were recruited from a senior living community in south Texas for this study. Participants had no neuromuscular condition that would significantly affect their ability to walk and reach without an assistive device. They also had no visual or auditory impairments. One control group consisted of nine participants. Since we were predicting differences in the effectiveness of training depending on age, participants in the intervention group were divided in two different groups: young-old (aged 65–73 years), with eight participants, and older-old (aged 74–81 years), with six participants. Both intervention groups went through the same process. At the end of the study, participants received an assessment of their physical abilities associated with functional and estimated reach and balance confidence. This study was approved by the Institutional Review Boards at Texas A&M University and the University of Texas at San Antonio.

## Tests

Tests of reach estimation were administered to each participant before and after the motor imagery training program. These tests were done using a specialized projector. The participants completed the tests in three conditions: seated, standing-two-feet, standing-one-foot. Each test required the participants to first get a maximum reach point (Figure 2). Then, one target at a time flashed along the line that the participants performed their maximum reach on. By using only their motor imagery and not actually reaching, participants had to state whether they thought they could or could not reach the target that appeared before them. At each height level a total of 35 trials occurred, requiring participant answers. To prevent improvement based on practice, the order that each participant completed the tests was randomized.



Figure 2. Body positions of the participants during the measurement of "actual" maximum reach.

### Motor Imagery Training Program

The motor imagery training program lasted 15–60 minutes, three times per a week, for 4 weeks and followed recommendations and strategies from Gabbard and Fox.<sup>2</sup> These considerations were addressed either in the specific single session training programs or in the facilitator's script for each session (Figure 3). Part of a single session of the motor imagery training program used in the study.

### Results

In the results, M is the mean number of targets (out of 35) during the reach estimation test that the participant correctly identified as being reachable or not.

### Condition Effect

Testing of the participants showed no difference in their ability to estimate whether they could safely reach a target regardless of the position. When we compared reach estimations in the three conditions, participants did

#### Week 1, Day 1

- 1. Explain program, goals, etc.
- 2. Position: Seated (record which hand person uses)
  - a. Reaching for Cup
    - i. Four Different Positions in a Line (have person far to the side of where the angles are marked)
      - 1. 3 inch over-reach
      - 2. 2 inch under-reach
      - no over- or under-reach
      - 1 inch under-reach
    - Four Different Positions at Angles (with 90 degrees in front and 0 degrees to the left)
      - 1. 0 degrees with 2 inch under-reach
      - 2. 135 degrees with no over- or under-reach
      - 3. 165 degrees with 2 inch under-reach
      - 4. 30 degrees with 3 inch over-reach
  - b. Reaching for Remote
    - Four Different Positions in a Line (have person far to the side of where the angles are marked)
      - 3 inch under-reach
      - 2. no over-reach or under-reach
      - 3. 1.5 inch under-reach
      - 4. 1 inch over-reach
    - ii. Four Different Positions at Angles (with 90 degrees in front and 0 degrees to the left)
      - 1. 135 degrees with 2 inch over-reach
      - 2. 20 degrees with no over- or under-reach
      - 3. 165 degrees with no over- or under-reach
      - 4. 120 degrees with 3 inch under-reach

**Figure 3.** Part of a single session of the motor imagery training program used in the study.

not have statistically significantly different total scores in the seated (M = 27.53), standing-two-feet (M = 29.07), and standing-one-foot (M = 27.93) conditions.

## Age Group Effect

Testing of the participants showed no difference in their ability to estimate whether they could safely reach a target regardless of age. Results for the three age groups indicated no significant difference in total scores between the control group (M = 28.76), compared to the young-old group (M = 27.41) and the older-old group (M = 28.63).

## Training Effect

Training in motor imagery improved the ability of participants to estimate whether they could safely reach a target in each of the three positions tested and regardless of age group. Participants that received training had lower total scores in the pre-test condition (M = 27.339) than in the post-test condition (M = 29.02) (Figure 4). The control group's scores from pre-test (M = 28.353) to post-test (M = 29.156) conditions were not statistically significantly different.

### Discussion

We compared the performance on a test of reach estimation among a control group and two motor imagery training groups categorized by age, young-old group (aged 65–73 years; mean, 70 years) and older-old group (aged 74–81 years; mean, 80 years). On the basis of previous research,

we expected to see that those who participated in the training program would show significant improvement in reach-estimation accuracy. Our findings supported this prediction, showing that a 4-week motor imagery training program did affect participants's estimation of reachability. As expected, no significant change occurred in the control group's scores.

Our results also noted no significant difference between reach conditions, a somewhat surprising result. In previous studies, participants are more accurate while seated than when standing. With standing, more risk is associated with the reach; therefore, more error in the judgments occurs. Even though participants were more likely to lose their balance or fall while standing-one-foot than when standing-two-feet or sitting down. this instability did not affect their reaching estimations. Participants were not more likely to be more conservative or uncertain about their reachability and underestimate when they felt less stable. All the participants in this study were elderly, and perhaps their accuracies were similar for all conditions.



**Figure 4.** Comparison of pre- and post-test scores between the intervention group (young-old and older-old groups combined) and the control group.

Even though we found no significant difference between the young-old and older-old participants, these results might be due to the small number of participants in each group. Increasing the overall number of participants might decrease the effect that individual differences have in each group, and with training more differences may emerge between groups. Therefore, future work is warranted to examine our motor imagery training.

The elderly population is a growing segment of our society, and their well-being is a major concern. The need is great for a solution to reduce the falls and injuries that these people suffer daily. Motor imagery training could be a potential solution to this problem, helping to reduce accidents and save lives. If future research continues to find the mental imagery training successful, this training could be implemented in nursing homes and rehabilitation programs since it is simple and time efficient.

### Acknowledgments

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# Read more on this topic from Ashley Fox in Volume 6 of *Explorations* at explorations.tamu.edu.

# The Search

# for an Antipathology Vaccine

# for **Schistosomiasis**

# Annalisa Erder

# Immunology Terms to Know

**Antigen //** a substance foreign to the body that causes the body to produce antibodies

**Downregulating //** reducing the effect of the body's natural inflammatory response

Courtesy: National Human Genome Research Institute (www.genome.gov)

## Introduction

Schistosomiasis is a waterborne parasitic infection that causes 200,000 deaths per year<sup>1</sup> in the tropical and subtropical regions of the world. Infection is common in the freshwater regions of sub-Saharan Africa, Brazil, and Venezuela that lack a sanitary water source. The disease is caused by three species of worms called schistosomes: *Schistosoma japonicum*, *S. haematobium*, and *S. mansoni*. and the spleen. Despite the constant activity of the worms, schistosomiasis progresses slowly and is difficult to detect. Its symptoms begin with a rash on the skin and develop into flu-like symptoms within 2 months of the infection. Schistosomiasis can be diagnosed via the presence of *S. mansoni* eggs in one's feces, but this method is not dependable because the eggs are produced only during certain stages of the worm's life-cycle. vaccines are vaccines that hamper the biological functions of *S. mansoni* and minimize the disease symptoms. For these reasons, our lab's goal is to create an antipathology vaccine to reduce the rate of infection and reinfection of schistosomiasis. To create this vaccine, **antigens** produced by the schistosomes must be identified.

*S. mansoni* causes two forms of schistosomiasis: an asymptomatic form and a symptomatic form. The

# "... owing to the poor water sanitation in these tropical regions, reinfection is common, especially in children."

Our lab is focusing on *S. mansoni*. The life-cycle of all schistosomes involves an intermediate snail host and a human host. In humans, the adult male and female worms live together and continuously release eggs in the veins that drain blood from the small intestine. Some of the eggs break through the human host's intestinal walls and enter the intestines to be excreted in human waste, whereas others are trapped in the liver. The eggs trapped in the liver cause an inflammatory response that can cause moderate to severe fibrosis of the liver

Schistosomiasis is reliably diagnosed only with a blood test.

Currently, those infected with schistosomiasis are treated with the drug Praziquantel. However, owing to the poor water sanitation in these tropical regions, reinfection is common, especially in children. Unless the water source is cleaned and the intermediate snail host population is eliminated, reinfection will continue to occur. One way to combat reinfection is to create an antipathology vaccine. Antipathology asymptomatic form is characterized by moderate spleen damage but otherwise limited debilitating symptoms. The symptomatic form is characterized by severe liver and spleen damage and has a significantly higher associated mortality rate. Certain antigen proteins produced in the antibody response of the asymptomatic form of schistosomiasis are absent in the symptomatic form and vice versa. This situation suggests that the antigens uniquely produced in the asymptomatic form may cause a response that is **downregulating**,



the proteins unique to the symptomatic form may be proinflammatory. By using the antigens unique to the asymptomatic state, our lab hopes to produce a vaccine that promotes the downregulating response in those infected with the parasite. In a first

**Figure 1.** SEA 2D gel pI 3-10, Coomassie brilliant blue stain, 4%–12% Bis-Tris.

step toward our goal, we have isolated and identified the antigens from each disease state and determined which are common to both.

## **Materials and Methods**

At the Biomedical Research Institute in Rockville, Maryland, mice with 20-week schistosomiasis infections develop the full chronic disease as seen in humans. Typically, 10%–20% of the infected mice will develop the symptomatic form of the disease. Our lab focuses on soluble proteins from the schistosome egg (S. mansoni egg antigen; SEA). Our protein analysis procedure involves two methods: two-dimensional electrophoresis (2DE) and Western blot. 2DE separates proteins according to their physical characteristics along an x and y axis, producing a rectangular gel of separated proteins like a map. We generated four identical gels. One was stained as a reference, and the other three were used in the Western blot analysis. A Western blot allows only the proteins that react to specific antibodies from the asymptomatic or symptomatic disease states to be seen.

After using 2DE to separate the proteins, we identified them by comparing our stained reference gel to a large-scale protein map generated in another laboratory.<sup>2</sup>

### Results

We repeated the 2DE and Western blot procedures four times, each time producing four gels. Each time, we stained one gel from 2DE (Figure 1) to show all the proteins in the protein "map." We used the other three gels for Western blot analysis. The Western blots were incubated in sera containing antibodies raised against control, asymptomatic, or symptomatic proteins, to identify the proteins that react to only one of the three types of antibodies.

We identified about 30 antigens represented in both disease states and a few present in only one or the other disease state. Three antigens have been identified as unique to the asymptomatic form (Figure 2, blue arrows). Two antigens have been identified as unique to the symptomatic form (Figure 2, red arrows).

### Conclusions

Future research will investigate the ability of the antigens



**Figure 2.** SEA unique to MSS and HSS as identified by Western blot shown on 2DE gel of SEA.

we have identified to generate antipathology vaccines, perhaps by using only those unique to the asymptomatic form to promote downregulation during infection. Some researchers have considered the possibility of combining antigens to enhance the effectiveness of the antipathology vaccine. Researchers at Alexandria University in Alexandria, Egypt, have investigated the combined effect of two specific antigens in mice infected with *S. mansoni*. The effect proved positive: it reduced the number of eggs found in the liver and intestines.<sup>3</sup> Future tests could involve preparing vaccinations with combinations of the antigens we identified, and with antigens identified as antipathogenic in other labs, in hopes of increasing vaccine efficiency.

Since schistosomiasis is a waterborne parasite, until clean water is available for all tropical regions, the best option to reduce rate of infection and reinfection is to create an antipathology vaccine. Future research should investigate the potential of antigens unique to asymptomatic schistosomiasis for use in antipathology vaccines to create a vaccine that downregulates symptoms during infection. We hope that our discovery of the antigens unique to each disease state of schistosomiasis will enable the generation of a more effective, life-saving vaccination.

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# PLACENTAL ADAPTATION DURING PREGNANCY IN THE FACE OF MALNUTRITON Robert Price Ruffin

### Introduction

With a rapidly growing global population, the task of feeding the world becomes more immense. Animal proteins, including beef, sheep, goat, pork, and poultry, are crucial in supplying nutrients to people around the world. However, much of the world does not consume beef; therefore, alternative animal protein sources are required. Sheep are the second most numerous livestock animal in the world after beef cattle, and many people rely on lamb and mutton as their primary protein sources.

Climate greatly affects the efficiency of global animal protein production. Large portions of the sheep produced in the world are located in arid climates, which are most likely to experience a great variation in forage availability and are more susceptible to drought. Because these operations typically utilize large expanses of land, forage and nutrient supplementation is a difficult management technique to use. It is crucial to identify animals that are better suited to these harsh and variable conditions, thereby increasing their capability to produce healthy offspring.

A healthy birth weight is important in reducing neonatal death in sheep. The mother's ability to transfer nutrients to her fetus during pregnancy contributes to fetal growth. If a fetus fails to reach its genetic growth potential before birth, the odds of neonatal death increase substantially. The goal of this research project was to determine the expression of two enzymes whose activity is essential for optimal nutrient availability in the placenta during pregnancy, with the hope of identifying females that are more adaptable to harsh climates. By identifying females that are better suited for harsh nutritional scenarios, producers will be able to increase production of sheep while decreasing losses attributed to low birth weights caused by malnutrition.

### **Background and Problem**

Sheep are the primary source of animal protein and clothing fiber for much of the world. Eight sheep consume the same amount of forage as one cow.<sup>1</sup> While cattle will rarely produce more than one offspring, sheep commonly produce two or three offspring. The combination of these factors makes sheep a favored species in much of the world because sheep can return more protein than cattle while using the same amount of forage.

One way to increase birth weights in offspring from sheep with insufficient nutrient availability is to increase the relative amount of nutrients available to the fetus through increased placental nutrient transport. Doing so should also increase the rate of fetal growth and development. The most effective way to increase nutrient transport is to

# **ACCOUNT OF FORAGE AS ONE COW.**

target the location of the transfer of nutrients from the mother to fetus: the placenta.

In mammals, the placenta serves as the nutrient transfer point between the blood of the mother and the blood of the fetus without the two blood supplies interacting. The development of the placenta depends greatly on the presence of polyamines. Because polyamines are carbon-nitrogen chains that are key components of placental DNA and protein synthesis regulation, converting the amino acid arginine to polyamines is essential for fetal growth and development. Reduced polyamine levels, which malnutrition can cause, can result in cells that cannot turn their genetic information into useful enzymes, thus restricting fetal growth.<sup>2</sup>

Polyamines are generated from the essential amino acid arginine.

The primary pathway by which arginine is converted to polyamines is through arginase acting on arginine, converting it into ornithine. Next, ornithine decarboxylase (ODC-1), the first enzyme of interest in the study, converts ornithine into putrescine, a common polyamine. However, recent evidence suggests that the placenta may have an alternative pathway for polyamine synthesis. First, arginine is converted into agmatine by arginine decarboxylase (ADC), the second enzyme of interest, and then to polyamines by agmatinase (AGMAT). Researchers believe that this alternative pathway is used when the placenta is deficient in ODC-1.<sup>3</sup> Figure 1 shows the biochemical pathways from arginine to polyamines. Mothers who can adapt to harsh climates might use both pathways to enhance nutrient transport to the fetus.<sup>4</sup> By comparing levels of these enzymes in these sheep, we can get a sense of how important polyamine synthesis in the placenta is for fetal health—and possibly identify sheep who are especially good at producing polyamines.

## **Materials and Methods**

To investigate the enzymes of interest (ODC-1 and ADC), we tested the expression of the genes that encode these enzymes. The basis of this study was to

investigate the relative amount of ODC-1 and ADC gene expression in the placenta of nutrient-restricted pregnant sheep who had high- and low-birth-weight fetuses. To measure expression of our enzymes of interest, we used a technique known as quantitative real-time reverse transcription-polymerase chain reaction (qRT-PCR).

We studied the placentome, a portion of the placenta where the fetal and maternal tissues are closely connected and greater than 85% of the blood flow between mother and fetus occurs. Because biological variation is an interest in our study, we used embryo transfer to limit the variance on the fetal side of the placenta. In embryo transfer, embryos from a genetically similar group of donor ewes are transferred into recipient ewes, the subjects of the study. Once they were confirmed pregnant, we randomly assigned ewes to either the treatment group or the control group. The treatment group began to receive half of their daily nutrient requirements, and the controls received their full daily nutrient requirements, in accordance with National Research Council requirements. We kept the ewes in separate pens and individually fed them once daily for 90 days. We weighed ewes weekly to adjust food intake for weight gain or loss. We recorded fetal weight and classified ewes as having either a high- or a low-weight fetus. We then collected the placental tissue samples, which we evaluated for gene expression changes.

### Results

Expression of ODC-1 was not statistically significantly different among the three groups (Figure 2) (p > 0.1). By contrast, ADC-1 tended to have a higher level of expression in nutrient-restricted mothers who bore heavier fetuses than in nutrient-restricted mothers who had low-weight fetuses. However, similar to ODC-1, values were not statistically significantly different between the groups (p > 0.1). All three groups had a sample size of 6, which is



Figure 1. Various biochemical pathways from arginine to polyamines.





generally accepted as a sufficient sample size in the field of Animal Science. We used analysis of variance to compare all groups. The trend observed for ADC-1 suggested that expression of ADC-1 may increase fetal size. The lack of statistical significance could be due to the relatively small sample sizes used in this study. Also, pending laboratory tests from a similar study may show statistically significant results for expression of ADC-1 and ODC-1.

### Conclusion

The expression of ODC-1 and ADC-1 among the treatment groups suggests that maternal diet may not affect these enzymes, and they may not influence fetal weight. These are important findings because they will allow us to shift our focus to other enzymes in the polyamine synthesis pathway. Understanding the effect of each member of the pathway will be helpful when determining biomarkers for selection of females that are more adaptable to harsh climates and nutrient restriction. These findings also suggest that even in cases of severe nutritional restriction, the female may be able to redirect nutrients in the form of polyamines to the placenta to ensure the survival of her offspring. This study only focused on one type of polyamine, putrescine. Although putrescine is one of the most important for cell growth, it may not be the limiting factor. Therefore, we are evaluating other members of the polyamine synthesis pathway(s) to ask whether other

# If a fetus fails to reach its genetic growth potential before birth, the odds of neonatal death increase substantially.

components are the key regulators of polyamines that affect fetal growth. Overall fetal growth may be affected by multiple enzyme relationships also. Once these markers are determined, we can work to develop diagnostic tests for producers, so that they may better identify females suited to survival and production in harsh climates and conditions of limited nutrition.

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# **VASCULAR STRESS ANGLE DEVICE: PURSUING ONE OF THE MOST PROLIFIC KILLERS IN THE UNITED STATES** Michael Draper and Brendan Swain

### Introduction

ardiovascular disease is the leading cause of death in the United States, killing nearly 610,000 people every year.<sup>1</sup> Atherosclerosis is a type of cardiovascular disease characterized by the development of lesions within the artery that may obstruct blood flow, potentially leading to a stroke or heart attack. Also, in cases where flow is not critically obstructed by the lesion itself, danger remains that the vulnerable plaque may rupture, releasing fragments that may become lodged in the vessel downstream, causing an embolism. Though the risk factors for vascular disease (such as diet, sedentary lifestyle) typically affect the body as a whole, the disease develops primarily in only a few regions of the vasculature: the coronary arteries, the carotid arteries, the iliac arteries, and the abdominal aorta. Why do these regions tend to be hotspots for the development of atherosclerosis?

To answer this question, it is important to review the forces that occur at a cellular level. Research has shown that endothelial cells, which line the inner wall of arterial vessels and form an interface with circulating blood elements, respond to the mechanical forces imposed upon them. These responses are vital to vascular physiology and are evidenced by physical changes in the cell that are observable under a microscope.<sup>2</sup> One such physical change is the shape of the cell, or the cell morphology. For example, arterial endothelial cells elongate in the direction of blood flow.<sup>3</sup> To better understand the underlying responses of endothelial cells in the onset of atherosclerosis, studies have applied known forces to endothelial cells and observed the resulting changes, such as changes in cell morphology. A better understanding of the responses to mechanical cues may enable the development of effective drug treatments for atherosclerosis.



Endothelial cells are subjected to two principal cyclic forces: pulsatile fluid shear stress (FSS) and pressuredriven circumferential stretch (CS). FSS is generated as blood flows across the cells, shearing them in the direction of fluid flow. CS refers to the stretching that occurs around the circumference of the vessel as it expands and contracts in response to internal pulsatile pressure variations. Endothelial cells are known to be sensitive to FSS and CS, as well as the interaction between them. When blood flows through straight arterial segments, as it does in much of the body, FSS and CS are perpendicular to each other; however, atherosclerosis is more likely to occur in arterial segments with complex flow patterns where FSS and CS are not perpendicular. For example, atherosclerosis is commonly found in arterial branches, where one artery splits into two, as in the carotid arteries. Computer modeling of blood flow in a carotid fork has revealed helical flow patterns in the carotid sinus—a region particularly prone to disease. Flow patterns such as these translate to a variance in the angle between FSS and CS, which we call the stress angle.

The common practice for subjecting cells to forces that are conducive to atherosclerosis (or proatherogenic forces) has been to apply FSS and/or CS stimuli that are similar in magnitude to those found in susceptible arterial regions. Most studies investigate the effects of only one stimulus, FSS or CS. These studies show significant differences in biochemical activity depending on the magnitude of the stimulus applied, whether CS or FSS. Studies combining these factors have employed straight mock arteries to show that FSS and CS produce significant synergistic effects when perpendicular. Such effects include a high level of alignment in endothelial cells<sup>5</sup> and variations in protein expression.<sup>2</sup> Until now, there has been no method for altering the stress angle between



**Figure 1.** Forces that act on cells induce biochemical responses in the cells. Biochemical processes drive a cell's physical activity. Therefore, physical adaptations can be used as an indicator of biochemical activity within a cell. By applying known forces to cells and observing the physical changes, we may learn about the sensitivity of cells to specific forces. FSS and CS in endothelial cell studies. This is important because in regions particularly prone to disease, this angle varies considerably from perpendicular. For the purpose of investigating endothelial cells in a more accurate mechanical environment, the Vascular Stress Angle Device (VSAD) was developed.

The VSAD is the first of its kind because it can subject cells to stress angle intervals between parallel and perpendicular. Using this device, cells can be subjected to conditions commonly considered resistant or susceptible, and those that are yet to be classified. This technology, combined with conventional biochemical assays, will allow unprecedented investigation of the effects of the mechanical cues commonly associated with regions particularly vulnerable to atherogenesis and the progression of disease.

### **Device Design**

To re-create the complex mechanical conditions associated with vulnerable arteries, we designed and developed a device capable of producing physiologic magnitudes of FSS and CS at various angles. The VSAD system can maintain a sterile, nourishing environment so that cells survive long-term investigation. The VSAD is also compatible with bright-field and confocal microscopy so that cellular responses can be observed throughout testing. Other considerations during the design process included ease of use and the potential to add features in future design iterations.

The method of controlling FSS used in the VSAD is based

on a modified version of the commonly used parallel plate flow system. This method allows the user to adjust the height of the chamber and the flow rate of fluid moving between the plates to achieve a desired FSS at the surface of the plates. By mounting a cell-seeded membrane on the top plate of our modified parallel plate flow system, the user can control the FSS he or she would like to subject the cells to. Flow straighteners installed at the inlet and outlet of the device help to reduce turbulence.

Control of the flow rate through the device is accomplished by attaching the VSAD to a flow loop, which includes components that accurately re-create blood flow. A gear pump is used to drive fluid through the loop and is driven by signals defined in real time. Pressure and flow rate feedback allow the system to be adjusted so that physiologic shear stresses and pressures can be achieved.

To control CS, the ends of the membrane are attached to a stepper motor capable of applying physiologic levels of stretch. The stress angle can be adjusted in  $15^{\circ}$  increments from 0–90° by rotating the membrane stage and stepper motor relative to the direction of fluid flow (i.e., the direction FSS).

### **Results and Significance**

We have re-created physiologic stretch waveforms (5% stretch) from both the carotid and subclavian arteries. Stretch waveforms can be derived from data in previous literature by using equations relating intravascular pressure and arterial wall stretch. We have also demonstrated real-time control of the flow rate through the VSAD. By using both controls in tandem, we can take a mechanical environment seen in a particular location of the body and apply it to our parallel plate flow loop.

Our ability to control both FSS and CS on a single platform, and the precision with which we can do so, are unprecedented in endothelial cell studies; however, this result represents only the first step toward our goal of

> re-creating susceptible vascular environments. The device also has to be able to implement CS and FSS at various spatial angles. By designing the device in a way that allows the stepper motor to be rotated, we can control the three parameters that make this device unique: FSS, CS, and the stress angle. When combining these three factors (flow, stretch, and the spatial angle that separates them), one can use the stress angle for cell studies of a particular region of the arteries.

> The VSAD differs from other flow loop devices by allowing the user to subject cells to a variety of stress







**Figure 3.** Stepper motor inputs and outputs for two CS waveforms. Graph a) and b) correspond to the stretch profile seen in the carotid artery. Graph a) shows the data generated by MATLAB, which was used as the motor input. Graph b) shows data from the encoder, a device that measures the position or output of our motor, with time in deciseconds. Graphs c) and d) correspond to motor input and output, respectively, for the subclavian artery stretch.

angles, a capability that is probably critical to identifying the cellular mechanisms that lead to disease. Furthermore, enhanced control of FSS and CS allow us to emulate any mechanical environment associated with particular regions of vasculature. With these controls the VSAD will give researchers a more physiologically relevant tool than has ever been provided for endothelial cell studies.

Our initial goal is to use this device in a cell study designed to investigate morphological adaptations to various stress angles. The correlation between stress angle and morphological adaptations will provide the basis for further studies targeting the specific cellular mechanisms responsible for the development of disease. Such studies may include measurements of protein expression and chemical signaling molecules in response to various stress angles. We hope that this tool will enable research leading



Figure 4. The completed VSAD, attached to a flow loop system.

to the discovery of potential pharmaceutical or gene-based therapies to combat one of the most prolific killers in the United States and other developed countries.

### Acknowledgments

We thank Dr. Michael R. Moreno for giving us the opportunity to work in his lab. We have discovered a love for scholarly research we would have otherwise not had the opportunity to explore. We also thank Steve Zambrano, a graduate student in our lab who has been a valuable mentor and the driving force behind the development of the VSAD. Also, the groundwork of this research comes from the countless hours of peers that came before us. Because of their

work, and the work of those who will come after us, this research has the opportunity to positively affect society as a whole.

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# Individualized Medicine: Vitamin D's Role in Cancer and Ethnicity-Based Medicine

Ashley Stonecipher, Moinuddin Syed and Shilpa Varrier

Courtesy: National Human Genome Research Institute (www.genome.gov,

#### Introduction

**D** very human is unique: we have different backgrounds, personalities, and appearances. Perhaps the most remarkable—and least understood—of our differences is our genetic code. In recent years, interest has grown in developing treatments tailored to the genetics of each patient, often referred to as individualized medicine. This form of medicine tailors treatment approaches and preventive strategies by considering the individual's genetic makeup. A practical proposition, this will usher a new era of medicine with the potential to greatly improve individual health. As President Barack Obama asserted in the State of the Union Address,

"[the] Precision Medicine Initiative [will] bring us closer to curing diseases like cancer and diabetes—and give all of us access to the

personalized information we need to keep ourselves and our families healthier."

Trends of genetic differentiation can be seen throughout history and have an evolutionary basis. The earliest fossil of the modern human *Homo sapiens*, which dates back to roughly 200,000 year ago, was unearthed in present-day Ethiopia.<sup>1</sup> A closer examination of specific genetic markers in the present human population showed that the first of our species set forth from Africa and began colonizing lands along the coast some 60,000 years ago. From migration sprouted genetic diversity, as humans were forced to adapt to different environments. Modern examples of human adaptations are found worldwide. Perhaps the best-known example is sickle-cell anemia and its correlation to malaria resistance. A mutation in the hemoglobin gene leads to sickle-cell anemia and protects the carrier of this mutation from malarial infection. Similarly, specific variations of *FADS1* and *FADS2* genes, which encode rate-limiting enzymes for fatty-acid conversion, are prevalent in villages in Italian Alps where cholesterol-rich foods are consumed in quantities that would cause heart attacks in other populations. In another instance, a specific variant of a gene that stimulates hemoglobin production, called *EPAS1*, is commonly present in Tibetans and helps them survive at high altitudes, where oxygen levels are lower than those at sea level. Individualized medicine seeks to understand these genetic differences and target treatment based on the

genetic background of each patient.

We are witnessing an increase in the human life span and associated age-related

diseases—most notably, neurodegenerative diseases and cancer. Our research focuses on the impact of human migration and the resulting genetic evolution, specifically of cancer mechanisms. A strong link between DNA repair capacity and cancer aggression has been well documented in the current literature.<sup>2</sup> Furthermore, recent research shows that the concentration of vitamin D in the blood is linked to the repair capacity of DNA in cells and therefore propensity to develop cancer.<sup>3</sup> Vitamin D deficiency in African American populations is well documented and is believed to be a result of the recent movement of the population away from tropical areas. Tropical areas receive more direct sunlight, which facilitates vitamin D processing. The population migrated to temperate

"Every human is unique . . .

zones, which receive less direct sunlight.<sup>3</sup> The vitamin D deficiency identified among U.S. African Americans thus may be attributed to decreased absorption of vitamin D that is modulated both by available sunlight and skin pigmentation.<sup>4</sup> Though a biological component may play a significant role in the early onset and greater severity of cancer symptoms in African American patients, no explicit explanation is apparent as to the underlying mechanism behind the dissimilarity.<sup>2</sup>

Here, we address this critical gap in knowledge by proposing a new, testable hypothesis: that the difference in cancer prevalence and aggression between the two populations is influenced by differences in DNA repair capacity associated with vitamin D deficiency and population-based variations in DNA repair enzymes. To test this, we evaluated the extent of DNA repair by using representative cell lines from African and Caucasian American populations, exposing them to chemotherapeutic drugs and treating a group of these cells with vitamin D to assess its effect on the cells. We expect to find differences in DNA repair capacity linked to variations in DNA repair enzymes, which lead to differences in vitamin D concentrations in the population. Damage to coding DNA strands is a relatively common natural phenomenon in which a mutation changes or inhibits the strand's expression. Inherent cellular repair mechanisms mend damage to maintain the cell's health and its ability to replicate in a controlled fashion. The cell cycle is a series of events that categorizes each aspect of cell replication: the G, phase is the stage of cell growth, synthesis (S) phase is responsible for DNA duplication, G<sub>2</sub> phase rectifies improper DNA replication of genetic information, and mitotic phase results in the division of cell. Cells that cannot sufficiently repair DNA can begin to accumulate damage, resulting in genomic instability leading to cancer.<sup>5</sup> Patients who have diminished DNA

repair ability are at much higher risk for cancer than patients with normal levels of it.<sup>3</sup> Some of the population-level differences in cancer characteristics are attributed to gene variants that affect the vitamin D metabolism pathways, resulting in varied vitamin D concentration levels among different populations.<sup>6</sup> Increasing the concentration of vitamin D could compensate for the low basal levels seen in certain ethnic groups and promote repair of damaged DNA, thus helping to maintain DNA integrity and stability. This in turn would reduce levels of damaged DNA present in the cells, which could help decrease cancer risk.7

### **Materials and Methods**

We selected 12 Caucasian cell lines and 12 African cell lines, all cataloged and

purchased from the 1000 Genome Project. All cell lines were from two populations that evolved separately, leading to distinct differences in their genes. We focused on variations in genes participating in DNA repair and vitamin D metabolism pathways.

After growing cells in media, we divided them into four groups: control group, control + vitamin D group, drug group, and drug + vitamin D group. By using the following procedure, we then prepared the cells for cell cycle analysis, which quantifies cells at each phase of the cell cycle: the DNA of all the groups were stained with a fluorescent dye. We then analyzed the cells with laser-based flow cytometry, a technique that counts cells and determines which phase of the cell cycle each cell is in on the basis of its staining patterns. Finally, principal component analysis, a statistical tool, was used to find trends in our experimental groups.

Each chemotherapeutic drugs we selected works through unique mechanisms to damage DNA, which curbs cell proliferation by restricting DNA replication. When DNA is damaged, dividing cells will arrest in S phase of the cell cycle, since the DNA can no longer be properly duplicated. The number of cells arrested in S phase after treatment with various drugs offers insight to the extent of damage the drugs inflict on DNA and the degree to which vitamin D can repair the DNA. We hypothesize that vitamin D increases DNA repair capacity, causing fewer cells to be arrested in S phase.

### **Results and Discussion**

As a first step to discovering whether African cells are more susceptible to DNA damage because of a lower level of vitamin D, we asked whether vitamin D could decrease drug-induced DNA damage. DNA damage causes cells to arrest in S phase, which can be monitored by our assay. In Figure 1, clustering to the left indicates more DNA



Figure 1. Principal Component Analysis of Cell Cycle Data.

damage, or less DNA repair capacity. Clustering to the right indicates less DNA damage, or greater DNA repair

capacity. The experimental groups varied with drug exposure. We see a clear separation between the control + vitamin D group (Blue +) and the drug treated group (Red x), showing that drug exposure causes DNA damage. The drug + vitamin D treated cells (Gray x) displayed two distinct clusters. These clusters are influenced by genetic variations between cell lines. Gene variations

associated with enhanced DNA repair capacity will shift the clustering to the right. The cluster located near the control + vitamin D grouping implies that the DNA of some cells was less damaged after exposure to vitamin D. Conversely, the cluster located near the drug grouping implies that the DNA of these cells had accumulated more damage, meaning it was not helped as much by increased vitamin D. Even though more trials are required to support the significance of the data, these initial results set a trend that would suggest that vitamin D does play a role in repairing DNA damage. Such a finding would solidify the foundation of our hypothesis and allow us to direct our attention to more specific topics, such as drawing preliminary associations between specific genetic variants and higher levels of DNA repair. Since the data were analyzed without regard to ethnicity, no ethnicity-based associations could be made at this time.

On the basis of the data, we intend to expand our research to associate DNA repair capacity with specific gene mutations that would allow us to identify DNA repair pathways that differ between African and Caucasian populations.

By correlating the clinical (phenotypic) differences in cancer presentation and outcome between African and Caucasian populations to the molecular underpinning (genotype) behind them, we plan to identify factors that can be exploited to eliminate cancer disparities. This study will not only prove beneficial in the cancer survival outcomes in African American and Caucasian patients but also represent a pivotal breakthrough in our quest for personalized medicine.

## Conclusions

Rapid human migrations from Africa have resulted in a mismatch between environment and the genome. Our research examines the intersection of vitamin D and aggressive cancer in the African population, particularly within the context of ethnic or racial disparities in the United States. By examining racial and ethnic disparities in disease patterns from the perspective of adaptation and evolution, research such as this and

"... a new era of medicine with the potential to greatly improve individual health."

other factors may clarify the etiology of many complex diseases and identify new approaches to prevent these

diseases in high risk populations.

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would never have accomplished our goal. This work is an offshoot of his daily mantra: "We are in the postgenomic era; it's time for the individual's genetics in the disease, not the disease in the individual."

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# **Author Biographies**

# Abdulla Baobeid

Abdulla Baobeid is a junior Mechanical Engineering major at Texas A&M University at Qatar, from Aden, Yemen. Baobeid is interested in biomedical engineering applications which can influence the health of people in the Middle East and underdeveloped countries for whom health care is either too expensive or inaccessible. Baobeid's other research interests include structural engineering and heat transfer.

# Julia Cisneros



Julia Cisneros is a senior Geology major with a minor in Geoinformatics from Pflugerville, Texas. Her project was inspired by the visible areas of disrepair on our campus. After graduating, Cisneros will pursue a Ph.D. in Geology at University of Illinois at Urbana-Champaign.

# Annalisa Erder



Annalisa Erder is a Nutritional Sciences junior with a history minor from Plano, Texas. Annalisa was inspired to work in immunology because of her passion for holistic healthcare. She recently completed an undergraduate research thesis regarding her work in this lab. Erder will graduate a year early to pursue a career in optometry.

# **Bethany Bell**



Bethany Bell is a senior Interdisciplinary Studies major from Bowie, Texas. She enjoys researching the communication aspect of conveying scientific thought processes through writing. After college, Bell plans to attend graduate school focusing on communication disorders and later becoming a licensed speech-language pathologist specializing in aphasia.

# **Brenton Cooper**



Brenton Cooper is a senior Economics and Philosophy double major from Spring, Texas. Cooper's interest in assessing the deterrent effect of "getting tough" on crime began after he followed New Hampshire's recent change of increasing the maximum age of juvenile jurisdiction. Cooper will be attending the University of Chicago Law School in the fall, after which he plans to pursue a career in appellate litigation before eventually reaching his long-term goal of becoming a judge.

# **Claire Casey**



Claire Casev is a senior Anthropology and English double major, with a minor in French, from Naperville, Illinois. Casey is passionate about studying the interplay between literature and folklore, and sees storytelling as a powerful window for breaking down barriers and understanding the experiences and identities of other cultures. Casey plans to pursue a master's degree in Public Folklore, after which she plans on applying the perspective of folklore to a career in museum and historical site education.

# **Michael Draper**



Michael Draper is a senior biomedical engineering with a minor in electrical engineering from Melbourne, Florida. Draper was inspired to work on his project due to his desire to help others. He hopes to further that goal with a job in technical services for an Electronic Health Record (EHR) company.

# Author Biographies cont.

# **Jeannette Flores**



Jeannette Flores is a junior Geographic Information Science and Technology major from McAllen, Texas. Inspiration for her project stemmed from the fierce pride that Aggies have for their university. Flores plans to work for a non-profit organization after graduation as a GIS analyst or an Environmental Consultant.

# Kaitlyn Kellermeyer



Kaitlyn Kellermeyer is a junior International Studies major from Double Oak, Texas. The inspiration for her creative piece was a collection of experiences as a service dog user. Kellermeyer used her interactions with strangers to understand how little things can have a meaningful and profound effect on others.

# **Ashley Fox**



Ashley Fox is a senior Kinesiology major from Helotes, Texas. She is also receiving minors in both Psychology and Coaching. Her research has been motivated by her desire to improve the lives of others. After graduation, she plans to pursue both a Master's degree and a Ph.D. in Occupational Therapy.

# Megan Krail



Megan Krail is a senior Interdisciplinary Studies major from Friendswood, Texas. Her research seeks to place a classroom emphasis on critical thinking in scientific disciplines. After college she wants to pursue a graduate degree in communication disorders and later become a pediatric speech language pathologist specializing in autism spectrum disorder.

# Aida Guhlin



Aida Guhlin is a junior Geography major with minors in English and Geoinformatics from San Antonio, Texas. Her work was inspired by her courses on GPS and Urban Geography. She plans to attend graduate school and eventually work for the Centers for Disease Control as a medical geographer.

# MacKenzie Kieborz



Mackenzie Kieborz is a senior International Studies and Psychology major with a minor in Spanish from Phoenix, Arizona. A study abroad experience in Jordan inspired Mackenzie to study the situation for women Members of Parliament there. Mackenzie hopes to become a clinical psychologist and work in crises and refugee situations.

# **Michael Martin**



Michael Martin is a senior English Rhetoric major and Communications minor from Kerrville, Texas. The real-life Bing Crosby inspired Michael to write about the psychology of a crooner under the demands of ultimate success. Martin plans to write creatively and pursue his passion for music wherever life takes him.

# **Megan McKeown**



Megan McKeown is a Meteorology major with a Geology minor from Houston, Texas. McKeown was inspired to study climate change due to her ongoing interest in the subject. After graduation, McKeown hopes to attend graduate school focusing on atmospheric chemistry and to eventually work for NASA to study planetary atmospheres.

# Faiyadh Shahid



Faiyadh Shahid is a senior Electrical Engineering senior with a minor in Mathematics from Comilla, Bangladesh. Shahid was inspired to work on cardiovascular diseases by the frequency of such diseases in America. After graduation, Shahid plans to pursue a Master's in Signal Processing and hopes to work on telemetry systems.

# **Robert Price Ruffin**



Robert Ruffin is a sophomore Animal Science major with Chemistry and Biochemistry minors from Mason, Texas. Ruffin plans to attend medical school with hopes of becoming an orthopedic surgeon.

# **Ashley Stoneceipher**



Ashley Stonecipher is a senior Genetics major, Business minor, from College Station, Texas. Inspiration for her project stemmed from the novel implications for the future of cancer treatment. Stonecipher plans to attend medical school after graduation, where she plans on pursuing a career in oncology.

# **Annie Salinas**



Annie Salinas is a senior History and English double major from Spring, Texas. Her work is inspired by the connection between music, story, language, and the things that get stuck in her head. After graduating, she plans to study philology and theology in graduate school and eventually become a professor.

# Brendan Swain



Brendan Swain is a senior Biomedical Engineering major from Houston, Texas. The inspiration for his research came from his love of learning about the human body and its inner workings. After college Swain plans to attend medical school and become an ophthalmologist.

# **Moinuddin Syed**



Moinuddin Syed is a senior Biomedical Sciences major from Houston, Texas. Syed's interest in studying the interaction between vitamin D metabolism and cancer stems from his passion for helping others, compounded with a fascination with the natural sciences. After graduation, Syed plans to pursue a master's degree in Biomedical Sciences at Texas A&M University before attending medical school and beginning a career in clinical medicine and translational research.

# Author Biographies cont.

# **Audrey Vincenzo**



Audrey Vincenzo is a sophomore Interdisciplinary Studies major from Northlake, Texas. Inspiration for her project stemmed from Georgia O'Keeffe's painting, "Purple Petunias." Vincenzo plans to obtain a Bachelor of Science in Interdisciplinary Studies and a Masters of Education to continue on to teach early childhood education.

# Iyan Younus



Iyan Younus is a senior Biomedical Sciences major and Neuroscience minor from Cameron, Texas. Inspiration for his article came from his time in the Reddy Lab at the A&M College of Medicine, where he helps develop novel pharmaceutical interventions for epilepsy. Younus plans to attend medical school to become a physician and hopes to continue doing research in his professional career.

# **Shilpa Varrier**



Shilpa Varrier is a senior Biomedical Sciences major from Grapevine, Texas. Varrier cites medical awareness as one of the primary inspirations for her research, as she hopes that the presentation of her findings will encourage her readership to be more proactive in their own lives when it comes to screening for diseases such as cancer. After graduating, Varrier plans to attend medical school and specialize in oncology, using clinical medicine and biomedical research to bring about positive changes in the lives of those affected by cancer.

# **Judy Yang**



Judy Yang is a sophomore Business major, Art minor from Arlington, Texas. After graduation, she plans to move to New York to work as a fulltime accountant and a freelance designer while continuing pursuing her designing dream in a fine art oriented school. Yang was inspired by the article, "The Golden Echo" to create a graphic representation of how certain phrases stick out to individuals when reading or listening to poetry. She is fascinated by minimalism and pulled on her inspirations from the genre to design the journal's Volume 7 cover. The layering technique is reminiscent of an echo, pointing to the theme of the cover art's article inspiration.

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- An abstract of no more than 250 words. The proposal should provide an overview of the project's objectives and methods. It should also include a description of the project's importance to the student's field of study and to others outside the field.

**NOTE:** Because *Explorations* is a multi-disciplinary journal targeting a general audience, please use non-technical language in your proposal. Necessary technical words must be defined.

The deadline for submissions is to be announced, however, submissions are typically welcome at the end of the fall semester. For more information, please visit **explorations.tamu.edu**.

# FORMAT FOR CREATIVE WORKS

- Only one submission per student
- All creative work requires a faculty endorsement. A faculty member in the field of your work must approve your piece for publication in a serious scholarly journal. If you have difficulty locating a faculty member to review your work, *Explorations* may be able to provide suggestions.
- All genres of creative work are welcome, however, due to the requirement for faculty endorsement, please remember that your submission should relate to creative work currently being taught at the university.
- Your work must be accompanied by a descriptive sidebar of 500-700 words. The sidebar must include:
  - Why did you choose this topic?
  - Who are your creative influences?
  - How does this style or medium help you to communicate your idea?
  - What studies were done to develop your piece? How did they contribute to its persuasiveness, depth, vision or styling?
- Please limit prose and poetry submissions to 3500 words. This word limit includes your scholarly sidebar, a minimum of 500 words.



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