

# **The Journal of Undergraduate Research**

at the University of Kansas

Second Edition | Fall 2009

ON THE COVER

Jayhawk Boulevard winds between Fraser Hall (left) and Lippincott and Dyche halls on the Lawrence campus. Courtesy University Relations at the University of Kansas.

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Dear Reader,

Thank you for reading the second edition of the University of Kansas Journal of Undergraduate Research, a peer-reviewed publication that aims to provide an outlet for exceptional undergraduate research performed at the University of Kansas.

After the success of last year's inaugural edition, we were thrilled to take over this high quality publication from Ryan Ellis, Nate Johnson, and Andrew Hodgson. It has taken more work (and time!) than we could have imagined, but we are delighted with the results. We made it our goal to include more articles based on hard sciences research, and we didn't disappoint. The second edition has twelve articles based on undergraduate research at KU, twice the number of the previous edition, with research was conducted in a variety of disciplines across the University.

Finally, we would like to thank everyone involved with this publication – the authors, faculty and undergraduate reviewers, and Editorial Board Members. Also, Dr. Christopher Haufler, whose patience, persistence, and expertise provided invaluable support for the publication of the second edition. Also, we thank the KU Honors program, which provided financial and institutional support.

You can find the electronic edition of this publication, along with information regarding subsequent issues online at <http://web.ku.edu/~kujur/>.

Happy Reading,



Kathleen Polonchek



Emily Tonsfeldt

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# Neurobiology and Ballet

The study of ballet is intrinsically reliant on the central nervous system and requires simultaneous activation of many neurobiological pathways. The central nervous system, composed of the brain and spinal cord, provides functional support to a dancer. This support is accomplished through activation of the sensory systems, the motor system, and cognitive areas. The sensory systems include auditory, visual, vestibular and somatosensory systems and allow for expressive artistry and balance. The motor system allows for both movement planning and execution. Cognitive aspects of the brain provide a dancer with the motivation and memory necessary to perfect and perform movement. The simultaneous activation of multiple central nervous system motor and sensory systems allows for the masterful execution and finesse typically associated with ballet.

Current national and international research has identified dance as a preventive activity for dementia. In addition, researchers at Washington University in St. Louis

recently published a study on tango and its correlation to improved balance and mobility in patients with Parkinson's.<sup>1</sup> These studies focus on single neurological diseases. The identification of the many areas of the brain involved in dance may lead to the use of dance in the treatment or even prevention of other neurological diseases and other applications in the fields of medicine and education. In light of the recent study of dance and neurobiology, this paper seeks to examine and catalog the brain functions integral to ballet.

## SENSORY SYSTEMS

The movement of dance, controlled by the motor system, is intrinsically dependent on sensory perception specifically relating to the auditory, visual, vestibular and somatosensory systems. Various stimuli are simultaneously transmitted and processed in these systems, which are responsible for rhythmic movement, spatial awareness, and balance.

The auditory system transmits pressure waves of musical sound through the outer, middle, and inner

ear to the cochlea. The cochlear ducts contain endolymph, which cause the basilar membrane to vibrate. This vibration controls the mechanotransduction channels in hair cells and ultimately the release of  $Ca^{++}$  channels. The influx of  $Ca^{++}$  triggers a release of glutamate and sends an action potential to the brain. The acoustic nerve forms at the center of the cochlea and joins the vestibular nerve at the internal auditory cortex thus forming the auditory nerve. The auditory nerve enters the midbrain and splits in many directions. It travels ventrally and dorsally to the cochlear nucleus. Other fibers travel to the opposite hemisphere by way of the trapezoid body. Still others terminate in the superior olivary complex, a nucleus in the pons, or in the nucleus of the lateral lemniscuses. Both the superior olivary complex and the nucleus of the lateral lemniscuses send fibers to the inferior colliculus, followed by the medial geniculate nucleus. The medial geniculate nucleus is thought to be responsible for detecting frequencies, intensity, and relaying this information to the auditory cortex.<sup>2</sup>

The auditory cortex, also called Brodmann's area 41, is located in the temporal lobe. It contains a topographical map of the cochlea and performs sound analysis by combining distributed but coordinated neuronal responses. The belt and parabelt regions are involved in processing rhythm.<sup>3</sup> The secondary auditory cortex receives input from the primary auditory cortex and processes melody, rhythm, and harmony. The superior lobe is involved in recognizing timbre. A short retention of auditory information and pitch relativity is processed in the right temporal neocortex.<sup>4</sup>

Sensory information received in the visual, vestibular and somatosensory systems play an

integral role in movement, posture and balance. Visual stimuli are received in the ganglion cells of the eye, which extend to the retina and project information to the optic tract by way of the optic nerve and optic chiasm. Axons from the optic tract form connections with cells in the hypothalamus and midbrain but most innervate the lateral geniculate nucleus of the dorsal thalamus. Axons from the lateral geniculate nucleus then project to the visual cortex, which receives information from both retinas. The primary visual cortex is Brodmann's area 17, located in the occipital lobe, which requires first a slight convergence in the striate cortex and next a huge divergence of information as information is passed on to higher, and as yet unknown, cortical areas. Brodmann's area 17 produces two large streams of visual processing: dorsal and ventral. The dorsal stream analyzes visual motion and the visual control of action. Thus it plays a role in navigation, motion perception, and eye movement. Eye movement is controlled by six extrinsic muscles, which respond to stimuli from both the dorsal stream and the vestibular system. The ventral stream is involved in perception of the visual world.<sup>5</sup>

Spatial perception occurs in both the cerebellum and the parietal cortex.<sup>6</sup> The cerebellum is involved in judgment of spatial orientation, made possible by its connection with the bilateral parietal lobe.<sup>7</sup> The parietal cortex is involved in spatial perception specifically during movement, translating visual stimuli into motor commands. The posterior parietal is active in egocentric, self-centered, spatial movement and body orientation. The precuneus, another part of the parietal cortex, is also involved in egocentric spatial perception. The precuneus is thought to present a map, providing body

awareness in regards to spatial positioning. This perception is important in ballet for control and correct orientation of the body. Navigating space during a leap or turn requires keen spatial awareness and direction.

The hippocampus, located in the parietal cortex, receives input from many sources and its ability to relate and combine this information is necessary for spatial memory tasks. The hippocampus is involved in allocentric, not self-centered, processing of spatial location and geometry of spatial scenes. Accurate navigation is associated with the right hippocampus and the right inferior parietal cortex.<sup>8</sup>

Spatial awareness is intricately linked to balance. The visual system maintains balance by perception of an individual's position location relative to their surroundings. The vestibular system detects movement of endolymph in the inner ear and as a result perceives equilibrium. The inner ear components involved in this perception are the semicircular canals and otolith organs. The semicircular canals detect rotational acceleration, or acceleration produced during a turn. The otolith organs sense linear acceleration and calculate the direction of gravity.<sup>9</sup> This positional perception contributes to the balance and spatial awareness required to execute a turn or leap.

The somatosensory system includes both the proprioceptive and tactile sensory systems. It includes afferent and efferent pathways, central integration and processing. These components make the system a paramount contributor to physical stability. The tactile system is stimulated by rotation or weight shift. These stimuli trigger peripheral receptors. Receptors are located throughout the body and mechanoreceptors play a specifically

important role in ballet through the tactile system. These receptors are composed of a peripheral axon whose cell body is located in the dorsal root ganglion, from which the thick myelinated nerve fibers of the mechanoreceptor enter the dorsal root of the spinal cord. This transmission of information next travels to the ipsilateral dorsal nuclei of the medulla oblongata.<sup>10</sup> Information passes from the medulla to the thalamus and ends in the primary somatosensory cortex located in the post central-gyrus of the cerebral cortex. This information, processed in other areas of the spinal cord, brain stem, and cerebral cortex, is transmitted to associated motor areas like the cerebellum and basal ganglia that are responsible for additional processing and regulation of motor responses. The spinal cord responds to muscle activation through reflex pathways. The brain stem is responsible for integration of stimuli from the visual, vestibular, and somatosensory systems to control posture. Both the spinal cord and brain stem act unconsciously to control balance and posture.<sup>11</sup>

The proprioceptive system reports the relative location of body parts and plays a role in physical stability. The system receives sensory information from nerves inside the body, located primarily in muscle spindles and joint receptors.<sup>12</sup> This sensory information is carried to the spinal cord and to the brain via the central ascending pathways. The motor system works closely with the proprioceptive system during ballet to constantly monitor and adjust movement for changing velocity, direction, and sequence.

## **MOTOR SYSTEM**

Immediate planning and decision-making also are required before successful completion of a turn or leap is possible. For example, a leap

is initiated long before the dancer begins to transfer weight and initiate movement. The decision to perform a leap occurs simultaneously in the superior parietal cortex, premotor cortex, and prefrontal cortex of the brain.<sup>13</sup> The axons that extend from these brain areas converge in area 6 in the motor cortex. Area 6 is the junction that converts the decision for movement into a physical act.

Neurons located in the lateral region of area 6, the premotor area, are stimulated during the decision-making process. These neurons are discharged once the task is initiated and then cease firing. The process of movement decision processing occurs in a motor loop that extends from the motor cortex to the basal ganglia, followed by the thalamus and culminating back in the motor cortex. The basal ganglia consist of the striatum, composed of the caudate nucleus and putamen, globus pallidus, and subthalamic nucleus.<sup>14</sup> The basal ganglia, in conjunction with the subthalamus, are involved in motor planning, eye movement, and management of skeletal muscle movement.

The information transmitted at the end of the motor loop travels to the lower motor neurons by way of cortical layer V of area 6. A leap, which requires very disciplined, precise, and large movement, involves a large neuron population. Individual pyramidal cells also are involved and drive motor neurons from different muscles involved in movement of the leg in a turn or leap.

The axons projecting from the layer V pyramidal cells in area 6 form a cluster in the pons and stimulate the cerebellum. The cerebellum is involved in control of critical motor control and is necessary for the execution of planned, voluntary, multi-jointed movements such as a turn or leap. The signal received in the cerebellum

instructs the primary motor cortex in regards to movement direction, timing, and force.<sup>15</sup> The practice of both turns and leaps, which are repeated during each class, allow for the generation of a new motor program in the cerebellum that generates the appropriate movement without scrupulous conscious control. This programming is modified by practice and forms as a result of previously discussed synapse alteration.

The brain controls movement through innervation of the spinal cord. Axons from the brain travel to the spinal cord in two pathways: the lateral pathway, which controls voluntary movement, and the ventromedial pathway, which controls posture and locomotion.<sup>16</sup> The lateral pathway axons originate in the motor cortex, areas 4 and 6, and end in the dorsolateral region of the ventral horns of the spinal cord. The lateral pathway itself, or corticospinal tract, originates in the neocortex and travels through the internal capsule that bridges the telencephalon and the thalamus. The pathway travels from the internal capsule through the cerebral peduncle, the pons, and ends in the medulla. Axons cross at the medulla, so the right motor cortex controls the left side of the body.<sup>17</sup> The ventromedial pathway originates in the brain stem and ends in the spinal interneurons that control proximal and axial muscles. The vestibulospinal tract functions to keep the head balanced on the shoulders as the body moves. The vestibulospinal tract originates in the medulla, where the lateral pathway ends, and projects bilaterally down the spinal cord to activate the cervical spinal circuits that control neck and back muscles. The tectospinal tract, also part of the ventromedial pathway, originates in the midbrain where it receives input from the sensory system. The tectospinal

tract is involved in orientating the head and eyes. Additional tracts, the pontine and medullary reticulospinal tracts, originate in the brain stem. The pontine reticulospinal tract involves antigravity reflexes of the spinal cord, specifically the ventral horns. The axons facilitate extensors of the lower limbs and help to maintain a standing posture. The ventral horns thus help to maintain rather than change muscle length. The medullary reticulospinal tract frees antigravity muscles from reflex control.<sup>18</sup> Both leaps and turns require the use of each of these pathways and associated tracts to control voluntary muscle movement and maintain balance and posture.

Once information has passed from the brain to the spinal cord, motor neurons innervate the somatic musculature. Lower motor neurons are located in the ventral horn of the spinal cord. The axons, which extend from these lower motor neurons, form bundles and create ventral roots that connect with dorsal roots and form spinal nerves. Among the 30 spinal nerves there is an uneven distribution due to the uneven distribution of skeletal muscle in the body. The spinal nerves contain both sensory and motor fibers that innervate distal and proximal musculature, such as the legs in a leap. Alpha motor neurons specifically control the generation of force by muscles. An alpha motor neuron and the muscle fibers it innervates create a motor unit. Varying the firing rate of motor neurons allows for graded contractions, which result from the release of the neurotransmitter acetylcholine. Sustained muscle contraction or increased force requires the summation of action potentials. In a leap, large muscles are innervated to shift weight and propel movement. These large muscles of the leg require thousands of muscle fibers. Leaps and turns are often

accented and accompanied by music. This rhythmic movement relies on the intrinsic pacemaker properties of individual neuron membranes and on synaptic interconnections.

### **COGNITIVE ASPECTS**

The physical execution of ballet is intricately tied to motivation and memory. Motivation is affected by emotion, which is a driving force of behavior. Emotion determines what is important, what deserves attention, and subsequently what is to be learned and remembered. The limbic system is responsible for emotion and therefore motivation.<sup>19</sup> It is composed of the amygdala, hippocampus, thalamus and hypothalamus. Sensory information enters the thalamus and is then moved to the amygdala for an emotional response and to the sensory and frontal lobes for fixated attention.<sup>20</sup> These regions and all other areas of the limbic system converge at the hypothalamus.<sup>21</sup>

The limbic system drives motivation through rewarding effects felt strongly by stimulation of the hypothalamus, and in a lesser degree by stimulation of the amygdala and hippocampus. The stimulation of the hypothalamus creates positive reinforcement through pleasure and consequently produces motivation. This motivation also has been shown to influence an individual's willingness to engage or disengage in activities.<sup>22</sup> The practice of ballet requires determination and persistence, traits developed and maintained in the limbic system. Enkephalins and opiates are thought to be the transmitters involved in this reward mechanism. However, the neural aspect of pleasurable reactions is not well understood.

The amygdala also is involved in emotion, specifically positive emotion and reward.<sup>23</sup> Like the hypothalamus it alters an individual's

willingness to respond to novel tasks and movements. In addition, the amygdala is involved in learning and retention of learned behaviors. The ability to apply learned behaviors in different situations and adjust to new environments also is accomplished by the amygdala. A ballet class utilizes repeated fundamental movements to produce innovative choreography. The ability to adjust a known movement to new criteria and spatial constraints allows a dancer to excel and succeed in the demands of this art form. The amygdala is intricately connected to many other brain regions, specifically the hippocampus, and for this reason the amygdala also serves a large role in memory.

The limbic system produces positive reinforcement for activities accompanied by pleasure. A release of dopamine during ballet creates positive feelings, promotes pleasure and increases motivation for continued pursuit and practice. This desire for determined activity then becomes reliant on memory and learning for continued progression and mastery of the art form.

Memory is another cognitive aspect active in ballet. Memories are formed in the medial temporal lobe, specifically the hippocampus, basal ganglia, amygdala, and entorhinal and perirhinal cortices. The hippocampus is important in declarative memory processing and contains the dentate gyrus, cornu ammonis, subiculum, and entorhinal cortex.<sup>24</sup> The dentate gyrus is one of the few regions of the brain that allows for neurogenesis and is located where nerves enter the hippocampus. The cornu ammonis is the main site of memory processing and is important in recalling memories from partial representations. Neurons loop back on themselves in this area creating an expanded output. The subiculum connects the hippocampus to the entorhinal and perirhinal

cortices and consequently allows for the integration of information from several areas. The entorhinal cortex transmits both input and output from the hippocampus and controls learning, which requires repeated experiences. The information gathered by the hippocampus from various sources contributes to rapid and unstructured memories. The hippocampus is actively involved in the process of memory storage but is not where memories are stored.<sup>25</sup> Each area of the hippocampus is actively involved in ballet, which relies on repetition and memory recall.

For example, turns and leaps can be broken down into fundamental movements of ballet, which are practiced routinely and repeatedly in class. This repetition allows for precise and perfected movement. Memories are produced by varying the firing rates of a neuron population stored by associative synaptic modification, which allows for later recall. The specific activity of the hippocampus and associated regions is useful in the remembrance of an entire combination when only specific components are initially remembered. A proper preparation or weight bearing can trigger appropriate movement recall and successful execution of leaps and turns.

The neocortex, specifically the prefrontal cortex, plays a role in working memory. It receives input from many sensory systems and involves the temporary storage of information and decision-making. This temporary storage is useful for the short-term memory required for many combinations given in class.

Repetition contributes to the formation of implicit memories such as skills, habits, and behaviors, which rely on the basal ganglia and neocortex. The basal ganglia are involved in both memory and movement. This region is useful in learning

sequential movement and plays a role in procedural learning. A region of the basal ganglia, the striatum, is composed of the caudate nucleus and the putamen and is located in the motor loop. This region receives input from the frontal and parietal cortex and transmits information to the thalamic nuclei and other cortical areas. The function of the frontal cortex, a region in the neocortex, is poorly understood but is thought to provide additional memory storage. The caudate nucleus is involved in learning and memory, specifically feedback processing. Coupled with the putamen, which regulates movement and learning, the striatum plays a large role in learning and memory because of its connection to many other brain regions.<sup>26</sup> The formation of memories is a result of synapse alteration. This marked change allows for recall and eventual mastery of specific ballet movements such as leaps and turns. Many details such as placement, force, and balance can be perfected through long-term memory formation and performed relying on only short-term

memory.

## SUMMARY

This paper is a reflection of the various activities of the central nervous system during ballet. Successful execution of movement relies on the integration of sensory input, motor planning, and cognitive aspects. Sensory input is received and processed in the auditory, visual, vestibular and somatosensory systems. The motor system facilitates movement planning and execution and relies on multiple brain regions including the superior parietal, premotor, prefrontal and motor cortexes. The cognitive aspects of ballet, motivation and memory, are controlled by the limbic system and various brain regions including the hypothalamus, hippocampus, amygdala, and basal ganglia. The concurrent integration of various sensory stimuli and movement requires simultaneous activation of many components in the central nervous system to produce functional support and finesse in a ballet dancer.

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# Generic vs. Name Brand

*Where is your money going?*

## INTRODUCTION

Consumers are attracted to the low cost of generic over name brand cosmetics. These generic brand products are marketed to be comparable to their respective name brand equivalents. This research group examined this claim using three pairs of cosmetic products as the testing pool. The name brand products are Olay® lotion with ultraviolet (UV) protection, Aveeno® Active Naturals® body wash, and Pantene® Pro-V shampoo with conditioner. All generic equivalents are sold under the Equate® brand and are available exclusively at Wal-Mart locations. To complete the project goal, three fingerprinting techniques were used to compare product composition, two physical properties of the products were determined, and an active ingredient in the lotion was quantified. In addition, a panel evaluated product performance.

## BACKGROUND

Liquid Chromatography with Mass Spectrometry detection (LC-MS) was used to fingerprint all the products. In liquid chromatography, samples are carried through a column by a liquid mobile phase. A mixture of water and acetonitrile was used as the LC mobile phase. Based on their structure, compounds vary in their interactions with a solid-phase column. The differences in attraction separate the compounds and cause them to exit the column at different times (elute).<sup>1</sup> After eluting off the column, product samples were pushed through a needle held at a high electric potential to convert neutral molecules to charged droplets. This technique, Electrospray Ionization (ESI), produces gaseous ions, which are necessary for detection by mass spectrometry, by evaporating the solvent under low pressures and high temperatures.<sup>2,3</sup> The gaseous ions were separated according to their masses and charged and detected by a mass spectrometer. Total Ion

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Chromatograms (TIC) and mass spectra were produced to compare the pairs.

Proton ( $^1\text{H}$ ) Nuclear Magnetic Resonance (NMR) Spectroscopy is an analytical method utilized to characterize compounds based on the chemical shifts of each compound present in the sample. Every multiplet in the NMR spectra corresponds to a proton in a different chemical environment. Identical proton shifts will indicate that the products contain structurally similar or identical compounds. Because each of the products is water-based, a proton NMR spectrum on straight sample would show a very large water peak providing relatively unimportant information and obscuring potentially useful information. Therefore, for each of the six products an aliquot of approximate mass 1.0g was placed into a desiccator to dehydrate the samples. After two weeks the aliquots were sufficiently dehydrated and prepared by adding approximately 3mL of  $\text{D}_2\text{O}$  to each of the six samples.  $^1\text{H}$  NMR spectra were taken using a 500MHz instrument. To compare spectra, the spectra were aligned in a manner conducive to elucidating differences between the spectral proton shifts.<sup>4</sup>

The two lotions each contain two active ingredients: octinoxate and zinc oxide. These ingredients are responsible for the SPF 15 UVB protection of the lotions by absorbing the light and emitting it as less harmful light.<sup>5</sup> Both products list the zinc oxide concentration as 3.0%. The FDA has determined that zinc oxide is safe at levels below 25%.<sup>6</sup> Flame Absorption Atomic Spectroscopy (FAAS) was used with standard additions to quantify the zinc oxide in the samples to both compare the two products and test the advertised concentration based on methods of Salvador et al.<sup>7</sup> The method of standard additions involves adding known amounts

of a standard to the sample, which allows the concentration of zinc oxide in the sample to be determined by extrapolation of the calibration curve. Octinoxate has been approved by the FDA at levels below 7.5%.<sup>8</sup> It is listed in both products at 6.0%. Salvador, et al.<sup>9</sup> were able to quantify octinoxate in sunscreens using HPLC with UV spectrophotometric detection and standard additions.

Since these products are used on the body, physical properties may play an important role in the overall feel and performance of the products. The density of any substance is determined by dividing mass by volume. The pH value of a solution is defined as the negative logarithm of hydronium ion concentration in the solution. Based on the value of the pH, a solution is categorized as acidic, basic, or neutral.

A fingerprint of each product was obtained using a High-Performance Liquid Chromatography (HPLC) system with Ultraviolet detection on a  $\text{C}_{18}$  column. A 100 mL dilution of all samples was prepared by diluting approximately 2g of the product with methanol. 20 $\mu\text{L}$  of this was then injected into the system. For the body washes and shampoos, a mixture of water and acetonitrile (ACN) was used for the mobile phase based on the work of Kiyoshima et al.<sup>10</sup> The mobile phase composition was held constant for the body washes (isocratic elution), but for the shampoos, the organic concentration was increased in order to elute the more retained compounds (gradient elution). The lotions were separated using an HPLC system with a diode array detector, taken from the work of Salvador, et al.<sup>11</sup> and a mobile phase of water and methanol.

## RESULTS

The TICs of the Pantene® and Equate® shampoos showed multiple peaks with matching retention times, suggesting that many compounds were found in both shampoos

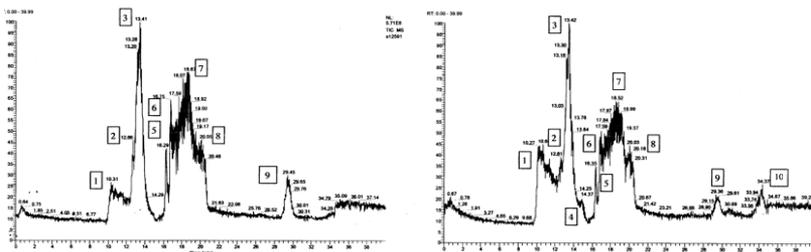


Figure 1. Total Ion Chromatograms of Pantene® (left) and Equate® (right) Shampoo

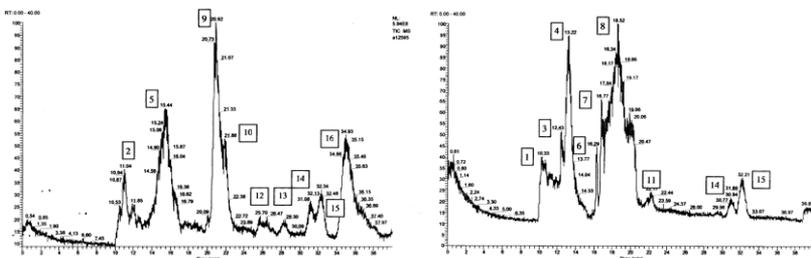


Figure 2. Total Ion Chromatograms of Aveeno® (left) and Equate® (right) Body Wash

(Fig. 1). Peaks 3, 5, 7, and 9, with approximate retention times of 13.4 minutes, 16.3 minutes, 18.5 minutes, and 29.4 minutes, respectively, are notable examples of peaks found on both TICs. The TIC of the Equate® shampoo had a few extra peaks (4 and 10) that are absent from the TIC of the Pantene® shampoo, indicating the presence of several unique ingredients. Nearly identical mass-to-charge peaks in the average mass spectra of both shampoos support the similarities of the TICs. Evenly spaced peaks separated by a mass-to-charge ratio ( $m/z$ ) of 44 suggest that a polymer was present with chain unit masses of 44 atomic mass units (amu). The Pantene® shampoo contains a polyethylene glycol, a family of polymers with repeating  $\text{CH}_2\text{-O-CH}_2$  units, that have a mass of 44amu. Polymers are identified by the number of units in their chains or their masses, but their names and

formulas represent average masses. Because some variation exists in the chain length, the products contain polymers with an array of different masses. The set of peaks 44m/z apart in the Pantene® mass spectra appears to represent a series of polyethylene glycols with different numbers of units.

A few of the peaks on the TICs of the body washes had matching retention times (Fig. 2). Peaks 14 and 15, with retention times of approximately 31.0 minutes and 32.2 minutes, respectively, were present in the TICs of both body washes. An additional peak in the TIC of the Equate® body wash, peak 11, eluted at about 22.2 minutes. There is no distinct peak matching in the Aveeno® body wash TIC, but a larger peak may be hiding the corresponding peak. The remaining peaks were unique to either the Aveeno® or Equate® body wash. The indication of formula

difference is further supported by the mass spectra. The mass spectrum of the Equate® body wash also suggests the presence of a polymer with peak separations of 44 m/z. Some peaks in the mass spectrum of the Aveeno® body wash are 44 m/z apart, but in general, separations between adjacent peaks are less uniform. The spacing differences may reflect the detection of additional compounds in the Aveeno® body wash formulation. Both products contain polyethylene glycol, which may have produced the series of peaks.

The lotion TICs had fewer distinct peaks than either of the other two pairs of products. Three peaks, with retention times of approximately 12.5 minutes, 13.3 minutes, and 18.5 minutes, were among the major similarities between the TICs of the Olay® lotion and the Equate® lotion. There was at least one distinct peak present in the TIC of the Equate® lotion that was missing from the TIC of the

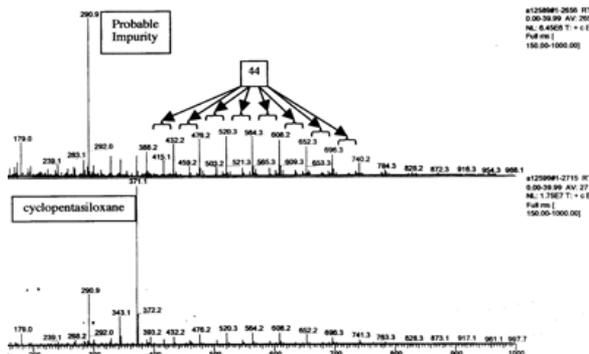


Figure 3. Mass Spectra of Equate® Lotion (Top) and Olay® Lotion (Bottom)

the Olay® lotion, suggesting that the Equate® lotion may have additional ingredients. The averaged mass spectra of both lotions also indicated the presence of a polymer with units of 44 m/z (Fig. 3). The polymer may be a polyethylene glycol, which is present in both lotions. The mass spectrum of the Olay® lotion has a strong peak at 371.1 m/z, and a smaller peak appears at a similar mass-to-charge ratio in the Equate® lotion mass spectrum. This peak probably corresponds to cyclopentasiloxane, which has a monoisotopic mass of 371.1 amu and is an ingredient in both lotions.

A peak at 290.9 m/z was present on all averaged mass spectra. The molecular mass of octinoxate is

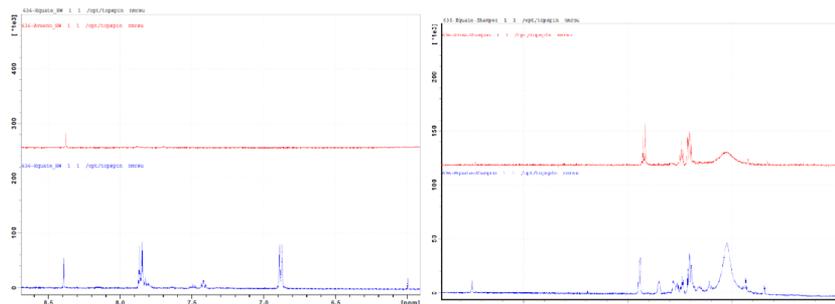


Figure 4. NMR Fingerprints of Aveeno® Top and Equate® Body Wash (Bottom) on left and Pantene® (Top) and Equate® Shampoo (Bottom) on right

290.2amu, but a universal impurity is the more likely cause of the peak. All mass spectra also show peaks at 179.0 m/z, indicating the possible presence of another impurity.

For qualitative comparisons of product formulations, the retention times of major peaks are the only reliable data that can be gained from the TICs. The samples were not originally prepared in identical concentrations and additions of differing amounts of methanol for subsequent sample reconstitutions further alter concentrations. Because the concentrations of the samples vary, comparisons of peak width, shape, and area, information often used for quantification are not valid. Compared to chromatograms produced by other separation techniques, TICs usually have relatively broad peaks, which is desirable because mass spectrometry takes time to detect a sample. If a compound elutes during a very brief time period, there is less time to analyze the eluent sample. However, broad peaks increase the probability of interference as one peak may contain the elution of multiple compounds which complicates analysis and quantification. Finally, electrospray is not a universal ionizer. Some of the ingredients may not have been ionized and therefore would not be detected by the mass spectrometer.

Qualitative analysis was performed on each of the samples' NMR spectra. The body wash samples appear quite different upon analysis. Though the region from 1.0 to 6.0 parts per million (ppm) appears to be similar, the region of interest for these compounds is the aromatic region. In the aromatic region of the spectrum from 6.0 to 8.0ppm, the Equate® body wash has multiplets 1 and 2 which the Aveeno® product lacks (Fig. 4). This suggests a difference in formulation between the two products. The Equate® product contains a

structurally different aromatic compound than the Aveeno® product. The two lotion samples' spectra show no proton shift differences in the region from 0 to 4.4ppm. In addition, the aromatic region of the shampoo spectra shows identical proton shifts. The high correlation between the two spectra supports high similarity in formulation between the two products. The NMR spectra of the two shampoo samples show almost identical shifts in all regions of the spectrum. The only difference comes in the aromatic region. Peak 1 has a slightly different shift in either of the products (Fig. 4). In addition, peak 2 is present in the Equate®, but not the Pantene® shampoo. The main difference between all the sets of spectra is the peak intensities between samples, which is most likely due to differences of concentration between the two prepared samples, since identical masses were not weighed for each.

Comparing the two chromatograms of the HPLC-UV-Vis for the Aveeno® and Equate® body washes (Fig. 5), there are several corresponding peaks present in both chromatograms. Peaks 1,2, and 3 eluted at 1.5,2, and 5.2 minutes. Peaks 4, 5, and 6 appeared at 9.5, 15 and 17.5 minutes in the Aveeno® body wash, but not in the Equate® body wash. The two body wash chromatograms indicate that the Aveeno® and the Equate® body washes have some similar components, but do not have identical formulations. The chromatograms of the Olay® and Equate® lotions (Fig. 6) both showed peaks 7, 8, 9, and 10 with retention times of 3, 4, 7, and 15 minutes, respectively. This indicates that the two products are relatively similar, but based on the respective intensities between peaks in a single product; the ratio of compounds differs between the products. The chromatograms of

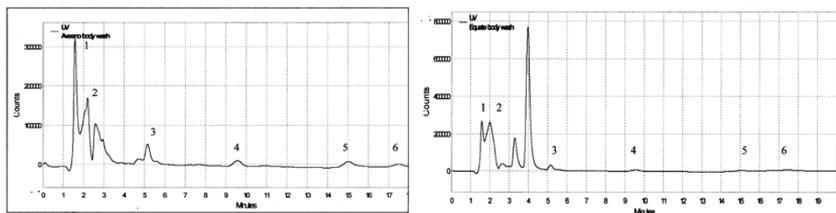


Figure 5. HPLC Chromatogram of Aveeno® Body Wash(left) and Equate® Body Wash(right)

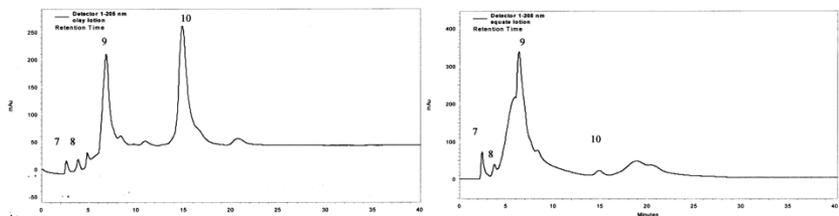


Figure 6. HPLC Chromatogram of Olay® Lotion(left) and Equate® Lotion(right)

the Pantene® and Equate® shampoos had several peaks similar to one another (Fig. 7). Peaks 11-19 appeared in both chromatograms at similar retention times. Of the three products, the shampoos' chromatograms showed the most similarities.

To quantify the zinc oxide, first, the instrument response was found to be linear in the 0.1ppm to 1.0ppm range. The limit of detection was calculated as 0.117ppm, while the limit of quantization was 0.389ppm. Through method development, it was found that the addition of hydrochloric acid to the sample increased the measured amount of zinc because the acid dissolved more zinc into the solution to be detected. The method was also improved by using a known certified zinc standard rather than dissolving solid zinc with hydrochloric acid. By testing various methods, it was found that obtaining an exact value for the concentration of zinc oxide was difficult because of the large dependence on the method of sample preparation. However, all 5 methods used showed the Equate® lotion

had a statistically significant higher concentration of zinc oxide, with over 98% confidence. Each method involved performing standard additions. The calibration curve from the Equate® lotion using the optimal method, number 5, showed a correlation of 0.9813 and 0.9292 for Olay®. While these are not exceptionally high, they were sufficient to show a difference between the two products, even with the error. All calibration curves from the other methods showed high correlation above 0.99. On these graphs, the concentration of zinc in the sample corresponds with where the line crosses the x-axis. The results from all the methods were compiled (Tab. 1).

One original goal of this research was to quantify the other active ingredient in the lotions, octinoxate. However, several factors made it unrealistic to accurately achieve quantification. The commercial standard obtained was only 98% pure. The chromatogram of the commercial standard showed several peaks, indicating multiple components.

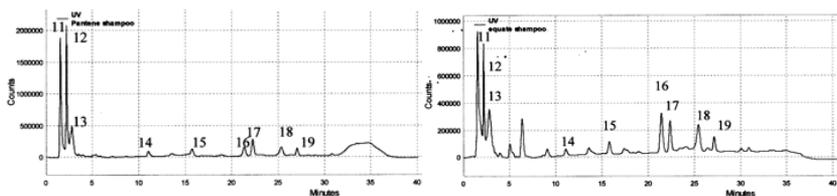


Figure 7. HPLC Chromatogram of Pantene® Shampoo(left) and Equate® Shampoo (right)

Several trials produced different chromatograms, making it difficult to identify the peak for octinoxate. Without a pure standard, the added concentration for standard additions would be unknown and quantification would be impossible.

The densities of the products were essentially the same except for those of the body washes. The body washes also showed the greatest difference in pH between the name brand and generic. The pH values of the name brand and generic shampoos and lotions were very similar, but the pH values of the two body washes differed by a value of 1.94, meaning that the Equate® body wash is almost one hundred times more acidic than the Aveeno® body wash.

Product testing suggests that the name brand was preferred over the Equate® for all three products by a 3:2

ratio in the body washes, a 4:1 ratio in the shampoos, and a 3:2 ratio in the lotions. The Aveeno® body wash has an overall better smell and was smoother, though the Equate® body wash foamed well. The Pantene® shampoo seemed to keep the hair less dry, while the Equate® lathered the hair well but left the hair frizzy. The Olay® lotion and the Equate® lotion had different characteristics but the Olay® lotion was preferred. The Olay® brand moisturized the skin better and kept the skin drier for a longer period of time; the Equate® coated well but left an oily texture.

#### CONCLUSION

In conclusion, the majority of our results indicate that while there are similarities between generic and name brand products, they are not as similar as consumers may be led to believe. Most of the fingerprinting

Table 1. Zinc Oxide Concentrations from Various Methods

	Method 1	Method 2	Method 3	Method 4	Method 5
% Zinc in Olay®	2.2% ± 0.5%	2.83% ± 0.02%	1.87% ± 0.04%	2.95% ± 0.02%	2.182% ± 0.010%
% Zinc in Equate®	2.7% ± 1.2%	3.16% ± 0.02%	2.44% ± 0.10%	3.69 ± 0.01%	3.367% ± 0.004%
%Confident different	98.1%	100%	100%	100%	100%

methods indicated that the name brand and generic products have some differences in their chemical formulations. The body washes showed the most differences in many of the fingerprinting tests, while the shampoos showed the greatest difference in consumer preference testing. The concentrations of ingredients may vary, but their affects on product performance are not always clear. Some compounds are vital to a desired function. Other ingredients are present as fillers or serve relatively trivial purposes and could easily be substituted without major changes in consumer satisfaction. The best product for a particular consumer may depend on personal preference and budget. The percentage price difference between name brand and generic products was greatest for the shampoos and least for the body washes (Tab. 2). However, the criticisms of the Equate® products did not relate to the amount of product needed but to the quality of product, so a simple cost analysis is not necessarily

adequate to determine the best value. If cost is a priority, generic products will likely be favored; they serve the basic functions of the products. Some consumers may find the slightly higher prices of name brand cosmetics are justified by improved product performance. Although a general consensus was achieved for two of the pairs, the sample size was small. Future product testing would benefit from blind performance trials among a large, diverse testing pool. Further research could seek to determine which chemicals were present in different amounts and how formula differences affect product performance. In addition the techniques outlined in this paper may be applied as analytical techniques for elucidating formulation differences between products. The analytical methods could be used to compare the known name brand products with the supposed counterfeits in foreign countries where counterfeit products rampant.<sup>12</sup>

Table 2: Walmart Prices of Products in Lawrence, KS

Product	Size	Price*	Percent Price Difference
Pantene® Shampoo	25.4 liquid ounces	\$5.47	75.3%
Equate® Shampoo	25.4 liquid ounces	\$3.12	
Olay® Lotion	6 liquid ounces	\$9.47	68.5%
Equate® Lotion	6 liquid ounces	\$5.62	
Aveeno® Body Wash	12 liquid ounces	\$5.97	53.9%
Equate® Body Wash	12 liquid ounces	\$3.88	

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# Effect of Evaluating a Recitals Course

## *Increasing Self-Efficacy in Undergraduate Music Majors*

### INTRODUCTION

Course evaluations are a major part of curriculum development at the university level. It is up to each institution to decide how to use the information they collect. At some universities the information is made available to all students to help them decide whether or not to take a course while others use them to decide tenure for professors. This study explores evaluation “non-traditional” courses. Is it possible to evaluate a course that doesn’t meet all together? Without clear student and lecturer roles, what can we infer from this data? This report seeks to discover whether or not the student’s feeling of efficacy will increase with the knowledge that they will fill out an evaluation at the end of the semester.

The literature on this subject covers many different aspects of course evaluation administration. Some explore the method of distribution and how that can affect the results.<sup>1</sup> Others involve researchers creating a course evaluation.<sup>2</sup> A Swedish study was performed in order to gain more knowledge about the students’

perception of course evaluations at the university.<sup>3</sup> A study by DiClementi found that a student’s classroom behavior and overall experience are positively affected by student input in the course.<sup>4</sup>

This project was completed in the fall of 2008 as part of an introductory research course. The hope is that this data will help provide administrators with the information they need to bring this specific course to its full potential. The data has already been distributed to the instructor as well as other faculty members who have expressed interest in the course. There are many people trying to understand the best way to accomplish the objectives of the course and help undergraduate students to realize its purpose as well.

### BACKGROUND/METHODS

All University of Kansas undergraduate students pursuing a Bachelor’s degree of Music or Fine Arts with a music emphasis take four semesters of a performance laboratory course. The course is listed in the University of Kansas undergraduate catalog as REC (recitals) 100. It is

referred to this way colloquially and throughout this report. While the requirements for the course have changed over time, these are the current guidelines.

The REC 100 course meets on Tuesday/Thursday at 10:00A.M. Anyone from the department can apply to perform during these class periods. Students in the course must attend ten of these “student recitals.” In addition, students must attend eight concerts outside of this class time. These happen almost exclusively in the evenings. Four of those eight must be KU ensemble concerts. The other four should be faculty or visiting artist recitals. Students are provided a list of these types of performances with corresponding dates and times. The list is updated on Blackboard throughout the semester.

Since all degree programs in the music department have a performance aspect to them, all music students participate in the university’s ensembles. Students are not allowed to receive credit for concerts in which their ensemble performs. Credit can be given for professional performances at the discretion of the course supervisor. Attendance is taken using recital monitors who are employed by the department. In addition to other responsibilities, they distribute slips of paper for students to fill out and return at the end of the concert. At this time, the course is taken for zero credit but has also been a half credit. Students receive an S (satisfactory) if they complete the requirements or a U (unsatisfactory) if they fail to complete the requirements.

David Bushouse is the current instructor of the course. He helped to provide background information about this course at KU. Historically, the course was not always required and was held in the afternoons. Professor Bushouse believes that the morning time on Tuesday/Thursday

has helped to increase attendance. Though it was not required, there have been a variety of techniques used to increase attendance. Also, for awhile, attendance was linked to a student’s applied lesson grade. Previously, standard KU course evaluations were distributed but this practice has been eliminated in recent years. According to Professor Bushouse, administrators in the Department of Music & Dance felt that the questions did not glean the desired information regarding the course.

The unique design of the course has been speculated as the reason for a lack of course evaluation. There are two reasons for this: getting that many people together could pose to be tricky and students might have trouble evaluating the instructor. Most of the questions on KU’s evaluation are focused on the students’ interaction with the teacher. However, it is quite possible to complete all four semesters of REC 100 and only see the teacher on the first day when the syllabus is handed out. Traditionally his role is to decide whether or not a concert outside of KU can be counted for credit and submit final grades.

This study was conducted by two undergraduate music majors due to negative perceptions voiced by large numbers of students about the course. Lacking ways to express specific frustrations or new ideas, we supplied a survey to serve as an alternative course evaluation. The website, [surveymonkey.com](http://surveymonkey.com) was used to format and distribute the survey. We used the standard course evaluation provided by KU as a base for our questions. We received permission from the department chair to distribute the link through an e-mail to all undergraduate music majors.

There were three components to the survey: a) Demographics b) Pilot Survey and c) Research Questions. The demographics section included

questions about major and year in school as well as the number of semesters they completed the course and number of semesters incomplete. The pilot survey was comprised of questions based on KU's evaluations and questions specific to the course that could potentially be reinstated for the department to gather information about the course in subsequent semesters. The final section asked about the facilitation of the course and whether or not the subject continued to attend concerts after completing all four semesters of the course. Additionally, students were offered two opportunities to comment about their experience or thoughts regarding the course.

## **RESULTS DISCUSSION AND IMPLICATIONS**

The purpose of this study was to gather student opinions on the course and to examine the effect of a course evaluation on students' perception of this course. Just under 50% responded with agree or strongly agree when asked if they thought a course evaluation would affect the course. The responses to the final statement suggest that the implementation of a course evaluation would be a positive change to the course. The students' individual comments also suggest some common suggestions and difficulties in the implementation of the course.

Out of the 133 undergraduate students who participated in the study, ten percent responded that they received an "unsatisfactory" grade on the course at least once. Students provided comments that were similar in nature ranging from suggested improvements, specific issues they had encountered, purpose of the course, communication between students and instructor as well as their opinion about the use of a course evaluation. There were very few comments that

contradicted one another. Out of the sixty-nine comments collected, only three offered no complaints or suggestions. In the remaining sixty-six, no suggestion or complaint was voiced only once. Because multiple students agree upon potential changes for the betterment of the course it is important that they have a medium to express those ideas and that those ideas are heard by administrators.

When examining comments from people who disagreed that a course evaluation would improve the course, it is clear that most of them believe the administration does not value the input of students. Out of the eleven comments about course evaluations, eight were negative. It is important to note that this attitude is present among students and while it's not the majority of people, that perception is still present.

All of the questions on the pilot survey used the scale mentioned above going from strongly disagree to strongly agree. A numerical value was assigned to each of these. 1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree. These numbers are used to calculate the mean and standard deviation. The highest standard deviation is 1.36 for the number of semesters enrolled. There were a couple individuals that received an unsatisfactory grade for several semesters. The mean for this question was 2.69 showing that most people taking the survey were in their third semester of the course or most likely sophomores.

Part of the course purpose is to instill the habit of concert attendance so that students will continue to attend even after completing all four semesters. The question asked, "If you have completed your required four semesters: Approximately how many times per semester do you attend recitals you are not required to attend?" The options given were

0-2, 3-5, 6-8, 8-10 and 11 or more. The mean is right in between 0-2 and 3-5. The standard deviation is 1.02. Fifty-three of the 133 people who took the survey answered this question. It is certain that some people didn't read the entire question and answered even though they were not done with REC 100. There are more answers for that question than there were upperclassmen and as it takes two years to complete, no freshmen or sophomores should have answered the question.

Overall this study suggests that there is a connection between student's perceptions of the course and the implementation of a course evaluation. It also suggests that there are ways that the course itself can be improved upon. The fact that students had opinions at all indicates the need

for a medium that students can use to express their feelings about this course.

A replication of this project could include some minor changes to questions in order to increase clarity and accurately represent the student voice. The evaluation could be longer and more specific. Comments indicated that some questions which were tricky to answer accurately. Also, the method of distribution is research-based and ensures privacy for all students. Students may be more inclined to fill out a course evaluation that will actually be submitted to the university rather than simply for research. As stated in the introduction, hopefully this data will be able help administrators decide what is best for this course and the music majors at the University of Kansas.

*Table 1. Means and standard deviations for each questionnaire item*

	Items	M	sd
3a	Semesters enrolled	2.69	1.36
4a	Semesters completed	2.68	1.19
4a	Semesters received an incomplete	0.31	0.81
1b	Course purpose being met	3.20	1.07
2b	Variety of events provided	3.72	0.95
3b	Related to my major	3.36	1.07
4b	Honest effort to learn	3.22	1.04
5b	Easy to complete	3.02	1.23
1c	Know who to contact about course	3.74	1.05
2c	Successful communication of requirements	3.78	0.84
4c	Course evaluation will effect the course	3.33	1.19

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## We Have Found a Witch! May We Burn Her?

Jane Wenham was your typical witch; a widow, old, not exactly the greatest neighbor, and practically destitute. After twenty years of being reputed to be a witch, charges were brought against her in 1712 for “conversing familiarly with the Devil in the shape of a cat.”<sup>1</sup> These charges, however, did not include what the peasants saw as the most damning evidence: the spectral tormenting of a maid. Jane, who was condemned to die by the jury who heard her case, never faced the executioner. She lived out the rest of her days in a small cottage on the estate of a kindly Lord. But why wasn’t she executed? There was the normal amount of evidence against her, and yet she was not killed. This happy reprieve was more than just a one-time miracle for Jane, it was indicative of the growing popular sentiment of the time that belief in witches and magic was a vulgar, hedonistic thing of the past, something which the learned gentry would rather laugh at than take seriously

### THE EVIDENCE

This arguably famous trial in

English history took place in a typical setting, a small town named Walkerne in the county of Hertfordshire, a place out of the way and seen as characteristic of backward country ways to the urbanized city dwellers of the time. To the educated elite, these country folk were full of superstitions about witchcraft and “not one of them with the least shadow of reason.”<sup>2</sup> Jane had lived in this town her whole life, and by her old age, was widely presumed to be a witch there. Her trial in 1712 was not the first time she had run into trouble with the law. For years she had had a dispute with her neighbor, John Chapman. Chapman, who was a farmer, had long suspected her of being a witch, attributing the deaths of livestock to her for years.<sup>3</sup> In 1711-12, the two ran into trouble when Jane supposedly bewitched his servant, Matthew Gibson, after he had refused her a bit of straw. According to witnesses, after his encounter with Jane, a woman in a riding cloak also came to Matthew asking for straw, he refused to give her straw as well. It was after this encounter with the unknown woman that he took off on a crazed journey in search of straw

himself. Going to several neighbors' homes and asking for straw, he finally stole some from a dung heap and carried it home in his shirt, which he had ripped off in the process. When asked to account for his behavior, all he could say was, "...he knows not what mov'd him to this, but says he was forc'd to it, he knows not how."<sup>4</sup>

While some witnesses were more than ready to believe the story of the young farmhand, not all were so convinced. A physician from Hertfordshire, seriously questioned the story, saying that based on his master's poor relationship with the accused, "that in order to better ingratiate himself with his master...to contrive this foolish capriccio of his own."<sup>5</sup> It is of course impossible to tell which is the truth, if Matthew Gibson really did become enchanted or not, but the latter explanation appears more plausible as, before this incident, Jane had borne no ill will towards the boy, and had indeed no conflict with him.

Chapman, who had however clearly never liked Jane, immediately went to confront her, calling her a "witch and a bitch." In response, the old "witch" lashed back, taking him to court for slander, a case which she won, and was paid a shilling in restitution by Chapman for his comment. This certainly was not the punishment she was searching for; Jane went away grumbling about getting real justice and cursing the Reverend Mr. Gardiner, the man who had decided the matter. To the witness, Francis Bragge, this was a rather suspicious slip of the tongue, a notion which the Physician shrugged off, pointing out that her anger was "what might drop from any person."<sup>6</sup>

All this took place on February the eleventh of 1711-12, and according to members of the Gardiner family, not an hour had passed before Jane seemed to find the justice she so desired. It

came in the form of the Gardiner's serving maid Anne Thorn, a newly crippled girl who had injured her knee in an accident. A strange person for Jane to take her ire out upon, as her trouble was with the parson, not his servant.<sup>7</sup> This aside, soon after Jane Wenham had left the house following Mr. Gardiner's verdict, Anne became possessed with this notion that she had to leave and go in search of sticks. In a stint remarkably similar to that of Matthew Gibson, she ran searching for these sticks a great distance, running into some of John Chapman's working men who later verified seeing her. It was on this journey, which reportedly happened in the span of only six or seven minutes, that she too came upon a woman in a riding cloak, who bade her to pick some sticks from an oak tree, wrap them in her gown (which she had by this time discarded) and secure the bundle with a crooked pin that the old woman gave her.<sup>8</sup> All of this came out after the Gardiners and a neighbor, Mr. Bragge, found the girl having a fit in the kitchen sans her dress.

This was but the first in a long series of 'fits' that the maid would have over the next month or so, in the time leading up to the trial and afterwards. Anne would continue to be tormented with pinches and pinpricks (witnesses testified that she continually came into possession of pins that had not been on her person before),<sup>9</sup> several times being mistaken for dead. It was during one such episode where they feared the maid had passed that Jane Wenham was finally forcibly brought to the girl, who immediately became animated once more; attacking Jane even and crying out for her blood. At the same time (February 15th), the Constable, Sir Henry Chauncy, was called in to press charges against Jane on behalf of the bewitched girl.

Jane, who had maintained her innocence from the start, at once

begged to be subjected to the water test, the archaic trial- by- ordeal method of determining innocence.<sup>10</sup> Ironically enough, the constable refused the experiment, as it was “illegal and unjustifiable.”<sup>11</sup> Instead she was asked by a minister from a neighboring town to repeat the Lord’s Prayer for the constable and the men who had brought charges against her. By this time flustered by the men around her, Jane tried several times and was unable to say the prayer correctly.<sup>12</sup> After asking for a respite, the men left her with her jailor, and return the next morning to question her again. It was that night that reportedly Anne was visited by a cat with the face of Jane, which tormented her greatly, until she was miraculously recovered by those in the room praying over her. This became a new tradition, which the townspeople not only took comfort in, but also thought this phenomenon proved their case to the fullest extent. They believed that God was rescuing her from the Devil in response to the prayers.

The next day, February 16th, having had time to compose herself, Jane again met with the Constable and men of the town, and again failed to correctly repeat the Lord’s Prayer. The men then got down to business and asked her if she had anything to do with the tormenting of Anne Thorn, a question which at first she declined to answer. It was at that point she was told by one of the men, Mr. Strutt, that, “if she was guilty of such a vile act, that it would be the best thing she could do, both for the salvation of her own soul, and the good of others, to confess.”<sup>13</sup> Jane then, for lack of a better term, caved, and began to confess. She admitted to not only being a witch and bewitching Anne Thorn, but also to taking the shape of a cat as her familiar spirit, which she used to torment Anne, and entering into a pact with the devil. The reason for her turning

away from God and going down this path sounds remarkably like a line from the *Malleus Maleficarum*,<sup>14</sup> as she says it was “a malicious and wicked mind...for when any of her neighbors vexed her she used horrid curses, and imprecations, on which the Devil took advantage over her.”<sup>15</sup> They then asked her to name others she worked with, and received the names of three women from Walkerne, all of whom were held for a week and then released, with no charges ever being filed against them.

Pleased with themselves, the men retired for the night, as the next day was the Lord’s Day, Sunday, but it was on this day (February 17th) that one of the strangest parts of this case took place. Up until this point, the townspeople had seemingly abided by the law in their makings of a case against Jane. They had refused giving her the trial- by- ordeal method; they had taken careful testimony, and they had even had four women carefully search for a witches mark on Jane. However, it was on that Sunday that underlying superstitions finally came out that worked against their case. It was that evening when those who were watching over Anne, the maid, decided to take some of her urine and pour it into a stone bottle, tightly cork it and hang it over a fire. Witnesses testified that during the time the bottle was over the fire, Jane herself fell into fits, crying and whatnot. However, when the bottle exploded up “like a pistol,” Jane returned to her normal self.<sup>16</sup> This was more incontrovertible proof for the townspeople.

That same night the Constable decided to avenge poor Anne, whom had all day been crying for Jane’s blood. When he found Jane with a pin “that came into her fingers,” he became enraged, thinking that she was meaning to harm the girl again. As he proudly testified in court, he saw it as further proof of her guilt. He therefore

took the pin from her and began to repeatedly stick the pin into her arm, often up to the head of it, trying to draw blood, which he said he did not.<sup>17</sup> It is indeed strange that Jane apparently did not bleed while being stabbed repeatedly with a pin, and with the prevailing belief being that when a needle is inserted into a witches' mark it does not bleed, there is little wonder that such an occurrence would have sealed impressions of her guilt.

Armed to the teeth with testimony against her, the Constable and townspeople took Jane to Gaol to face prison and trial. All the way to the prison she was recanting her earlier confession and begging her jailors to release her. While in prison awaiting trial, the townspeople ransacked her home and also found in the pillow of Anne curious little feather cakes which could not be taken apart by human hands. Thinking these cakes an evil charm, they decided to burn the lot, thinking "...and not without reason... would have it all burnt in hopes the effects of [the charm] might cease,"<sup>18</sup> not saving one as evidence for trial.

## THE TRIAL

The townspeople came to trial hoping to have a trial that mirrored the case of Julian Cox, who set the precedent in 1663 for being executed for tormenting a maid in much the same way that Jane supposedly had. Their hopes were somewhat dashed by the fact that the only official charges brought against Jane were on her familiarity with the Devil and taking on the form of a cat to do so.<sup>20</sup> Not completely disheartened, thinking the testimony about the afflicted girl would be evidence enough to convict, they brought forward a grand total of sixteen witnesses against Jane. None came in her defense, the accusers gleefully noted, as not even Jane's children had come to speak for her. This was not hard to understand

from an outsider's perspective, as many relatives of convicted witches were often tried on the basis of their relationship to the condemned alone, notwithstanding testifying on their behalf. These advantages the townspeople of Walkerne thought they had amounted to little, however, when met with the person of the Judge, the honorable Lord Powell.

If there was to be a hero in this story, Lord Powell was beyond a doubt it. In the words of a contemporary, Francis Hutchinson, "...the tryal being before a judge of learning and experience, he valued not those tricks and trials."<sup>21</sup> Lord Powell was representative of the growing public sentiment of the upper classes that witchcraft was nothing but a vulgar belief held by ignorant people. The learned upper classes were beginning to think that believing in witches and magic was a lower, more primitive way of thinking, "which has its residence only in the weak and cowardly understandings and tempers."<sup>22</sup> Clearly from the start of the trial on March 9th, the Judge thought little of the charges, and even less of those who had brought them forward. Famously he told one witness in response to an allegation that Jane flew to the witches Sabbath that it is not a crime to fly. And he took this sardonic approach to the whole of the trial, and is veritably the reason it did not become the circus that the court of Salem did during their own witch trials, with the afflicted taking an active part in the proceedings.

As more than one person at the time pointed out, the trial of Jane Wenham already had much in common with the infamous trials of Massachusetts. As far as evidence was concerned, the two were identical, as both were entirely "trusted to the spectre evidence."<sup>23</sup> And at the outset of the trial, it appeared Anne Thorn had every intention to disrupt the trial

as the afflicted in Salem did, falling into a fit at the sight of Jane Wenham when called to testify. Unlike the Judges in Salem, however, Powell was not about to stand for such nonsense. When the townspeople asked to be allowed to pray over her as it would bring Anne out of her fit, the Judge refused, telling them: "She will come to herself by and by."<sup>24</sup>

This was not the only time the notion of prayer being used to combat the girl's fits was discussed. The Reverend Strutt, the same who had asked Jane to recite the Lord's Prayer and goaded her into confessing, testified to the fact that not only could Jane not say the Lord's Prayer, but also that said prayer could be used to heal Anne. The Judge met this with the skepticism many at the time had for such superstitious beliefs, saying: "That he had heard there were forms of exorcism in the Romish Liturgy, but knew not that we had any such in our church. However, he was glad to find there was such virtues in our prayers."<sup>25</sup> It was only then that, for the sake of evidence, he allowed Anne to be brought out of her fit through prayer.

Then the story of the odd feather cakes found in the pillow of Anne after the accused had been taken to Gaol was brought up. After having the cakes described to him in great detail, the issue of evidence came up once again as the Judge questioned the fact that none had been brought to court. As the account of the trial goes, "[Powell] said, that he wish'd he could see an enchanted feather; and seem'd to wonder that none of these strange cakes were preserved."<sup>26</sup>

The last to testify were two women, Susan Aylott and Elizabeth Field, each of whom accused Jane of killing a child of theirs. When the fact came out that both of these deaths had taken place over twelve years ago, the Judge questioned Elizabeth

why she did not immediately bring charges against Jane if she was so sure of her guilt. Elizabeth responded that she had been to poor at the time, an answer the Judge countered by asking, "Whether she was grown rich since?"<sup>27</sup> Elizabeth answered in the negative, saying that she just seized upon an opportunity.

Before sending the Jury out to deliberate, both Jane and her advocate, Powell, spoke to them. Jane, for her own part said little, just asserting that she was a "clear woman." The Judge was more direct, telling the jury after summing up the case to them that it was "left to them, whether it was sufficient to take away the prisoner's life."<sup>28</sup> The jury spent little time deliberating, and returned shortly with a guilty verdict. Judge Powell then, "tho' he was forc'd to condemn her, because a silly jury would find her guilty, sav'd her life."<sup>29</sup> This is, in essence, what he and another man, Colonel Plummer of Gilston, did. For his part, Lord Powell set aside the verdict, granting her a reprieve. The Colonel, "a sensible gentleman, who will for ever be in honor for what he did," took her into his protection and set her up in a cottage on his estate where she could live safely away from the people of Walkerne who would undoubtedly have killed her. It was in this shelter she lived out the rest of her days, peacefully dying of old age and natural causes. This was hardly the execution the people of Walkerne hoped for.

## CONCLUSION

But why did Jane escape the hangman when so many before her, when charged with the same crimes, did not? The answer lies in the times. Jane had the fortunate luck to be tried at the beginning of the eighteenth century, when witchcraft beliefs were not only no longer popular, but looked down upon and often laughed at.

The highly educated began to equate belief in witches with heathens, as all the stories were founded in pagan tradition; or, as one author at the time put it: "this strange notion of witchcraft has its foundation in heathen fables."<sup>30</sup> It was a time when not only were the ideas which founded the trials were being called into question, but also the legal structure used to prosecute them. The use of torture to find the truth and gain confessions was no longer sitting well with the majority of the population. People were starting to realize that, "the wisest men in the world may be brought, by imprisonment and torture, to confess to any thing, whether it be true or false."<sup>31</sup> People over the last century had become increasingly concerned with the use of torture, and the possible abuse of it in all criminal cases, especially in that of witchcraft. No longer was it found to be reliable as more and more people pointed out that innocent people would confess to absolutely anything in order to stop the pain. And as the confessions gained by torture were often the only "conclusive" evidence in a witchcraft trial, the practice came under fire as people were being condemned to die on nothing more than questionable

confessions. Whether given under duress or not, confessions no longer were seen as the end all be all piece of evidence to seal shut a case.<sup>32</sup>

It is clear that Jane was saved by the time in which her trial took place. As was made clear by the example of Julian Cox in 1663, in earlier years people had been killed for what she had been accused of. In the end, the case against her consisted of her threatening Anne, her subsequent presence when Anne recovered, and her "free" confession. This was enough for a jury to sentence her to death, but at the same time too little for a judge to condemn her to die. And thanks to this judge, and others who shared his opinion, Jane escaped the fate of so many reputed witches before her, and lived happily into old age. This trial, in the way it was carried out, is a perfect case for the changing times, an era when science was at the forefront and what was seen as backwards hedonism was pushed into relative obscurity. In it are all the classic features of a witchcraft trial, except for the reprieve granted at the end, which instead shows the moving forward of the judicial process and societal concepts towards what was arguably a more modern stance.

## END NOTES

1. Francis Bragge, *"A Full and Impartial Account of the Discovery of sorcery and witchcraft, as practic'd by Jane Wenham of Walkerne"* (Printed for E. Curil, London, 1712), 28.
2. Physician in Hertfordshire, *"A Full Confutation of Witchcraft..."* (Printed for J. Baker, London, 1712), 42.
3. *Ibid*, 5.
4. *Ibid*, 6.
5. Physician in Hertfordshire, 6.
6. *Ibid*, 7.
7. Physician in Hertfordshire, 8.
8. Bragge, *"A Full and Impartial Account..."*, 8.

9. *Ibid*, 23.
10. *The traditional water test, is one of the best known examples of the old judicial standard of proof "Trial by Ordeal." In such a case, the accused would be subjected to some sort of ordeal, the outcome of which would determine their guilt. The water test, as satirized in the film "Monty Python and the Holy Grail," a suspect witch would be bound and thrown into the water. If they floated then clearly they were a witch, therefore guilty and burned; whereas if they sank and drowned they were innocent, although still dead. By the late seventeenth century, however, this process was seen as barbaric, as the new standard of proof became a confession gained under torture.*
11. *Ibid*, 16.
12. *It is worth noting that the mistakes that she made were grammatical, for instance: "Lead us not into temptation but deliver us from all evil" rather than "Lead us not into temptation and deliver us from evil." Bragge, 16.*
13. *Ibid*, 19.
14. *The Malleus Maleficarum, otherwise known as the 'Witches' Hammer,' was a guide book published by one Heinrich Kramer and Jacob Spranger. In short, it was intended to be used by prosecutors and inquisitors to find and prove the guilt of suspected witches. It also is an incredibly misogynistic document that was largely Kramer trying to assert religious supremacy over judicial in the case of witches, as he had been thwarted in earlier attempts to condemn witches to death. Following its publication, it was widely used throughout Europe in the witch hunts.*
15. *Ibid*, 20.
16. *Ibid*, 24.
17. *Ibid*, 23.
18. *Ibid*, 27.
19. Joseph E. Baker, "The Witch, No. 3" (Walker, Geo H. & Co.), 1892.
20. *Ibid*, 28.
21. Francis Hutchinson, "An Historical Essay Concerning Witchcraft" (Printed for R. Knaplock and D. Midwinter, London, 1720), 165.
22. Unknown, "Impossibility of Witchcraft..." (Printed by J. Baker, London, 1712), 5.
23. Hutchinson, 164.
24. Bragge, 28.
25. Bragge, 29.
26. Bragge, 31.
27. Bragge, 32.
28. Bragge, 33.
29. Hutchinson, 165.
30. Unknown, 12.
31. Unknown, 32.

32. *Brian P. Levack, The Witch-Hunt in Early Modern Europe (Pearson Education Limited, UK, 1987), 261.*

## Terror as Repression Inside the Favelas of Rio de Janeiro

In Brazil, Rio de Janeiro is commonly referred to as the “marvelous city.” Surrounded by the ocean and steep hills covered in green, the city has always been the postcard of the country. Rio, the second largest city in Brazil, is also a large economic center, and features some of the most expensive real estate in the country. However, Rio is also a city of contrasts and inequalities. Approximately 20 percent of its population lives in favelas, a type of shantytown.<sup>1</sup> These people live a life surrounded by violence from both State and non-State actors resulting in what Michael Taussig, in his study of rubber trade in the Putumayo, calls a “space of terror.”<sup>2</sup> However, these areas did not become spaces of terror by accident, they are the product of a historical process that elaborated ways of creating a certain stability for the upper classes in a country with extreme levels of economic inequality.

The Brazilian government often argues that the violence used inside the favelas is necessary to combat drug dealers. However, the methods employed by the police, such as

general search warrants that allow them to invade any house,<sup>3</sup> hardly differentiate between innocent favela residents and criminals. Therefore, a series of questions needs to be considered. What kind of violence does the State use against favela residents? What are the effects of this violence? What legitimizes violence against this specific segment of society? Louis Althusser’s concepts of Repressive and Ideological State Apparatuses<sup>4</sup> are helpful tools to understand the situation. The police in Rio works as part of the Repressive State Apparatus (RSA), while other institutions, especially the media, function as Ideological State Apparatuses (ISA) that legitimize an ideology that tolerates, and even encourages, violence against a specific group of subalterns: the favela residents. The methods used by the police can be qualified as state terrorism, which, according to Jefferey Sluka, another theorist of State terrorism, “refers to the use or threat of violence by the state or its agents or supporters, particularly against civilian individuals and populations

as a means of political intimidation and control.”<sup>5</sup> The terrorism carried out by the State helps sustain a space of terror that contributes to the marginalization of these communities and suppresses their political power, thus preserving a status quo plagued by inequalities.

### **FAVELAS: MARGINALIZED SPACES**

The favelas began to appear along the hills of Rio de Janeiro in the end of the 19th century. At first the government attempted to eliminate them, but eventually it began to take action to urbanize these areas.<sup>6</sup> The urbanization project had limited success and today these shantytowns are located alongside upper-class neighborhoods. Compared to the rest of the city, residents from the favelas have always been underserved or excluded from state services such as education, sanitation, health care and security. The absence of the State in these areas leaves a vacuum that was occupied by drug traffickers, who now base their operations from the hills and sell drugs in lower areas of the favelas that border the urbanized city. These spots are called bocas (mouths) and are accessible to the upper classes. The traffickers are organized into factions that fight amongst themselves for control of different favelas and bocas and who fight the State to maintain what in turn is a very profitable business. The majority of the favela population is stuck between these various conflicts.<sup>7</sup>

Because of these contrasts binary oppositions have appeared contrasting the urbanized city with the favelas – the most common being morro (hill) to refer to the favelas and asfalto (asphalt) to refer to the city. People from each of these environments rarely socialize with one another; one of the major exceptions being instances of crime. The lack of social interaction results on the marginalization of favela

residents. They are habitually referred to as favelados, a pejorative term. The word favelado often evokes the image of a black man, probably in his early twenties and dressed in shabby clothes, thus adding a racial component to the situation. There is a strong narrative of Brazil as a “racial democracy,” which only recently has been undergoing criticism.<sup>8</sup> Even though Brazil is a highly miscegenated country – and the favelas a diversified space – in urban centers a majority of black people live in these shantytowns. This is due to Brazil’s modernization project, which failed “to incorporate large segments of the population into modern sectors of the economy, society, and political system” and resulted on the exclusion of these social groups from certain rights and services guaranteed by the government.<sup>9</sup> Therefore, the situation in Rio and other urban centers in Brazil can be defined as social apartheid; large segments of the population are concentrated in a certain area and excluded from certain rights. Even though for the most part the favelas are not walled-off, the police sometimes establish checkpoints to search for drugs and weapons. Also, the rich have built walls with electric fences around their condominiums. The division between favelas and other spaces is clearly defined and it is the side on which one is situated in that determines his or hers identity.

### **THE INSTITUTIONAL FRAMEWORK OF THE BRAZILIAN MILITARIZED POLICE**

The Brazilian police system is divided into three forces, each of them having a specific function. However, instead of creating a more efficient police, this specialization fosters animosity and results in an increased use of illegal violence in the competition for criminals.<sup>10</sup> Today, the role of the federal police (PF) is mostly reduced to patrolling the borders

and dealing with immigration. The civil police (PC) are non-uniformed and exert a juridical role by running criminal investigations. The militarized police (PM) are uniformed and work to prevent and intervene with any crimes taking place. The PM patrols the streets and usually makes the arrests, once an arrest is made the criminal proceeding is passed to the PC.

Because of the nature of the PM's work, it is the force usually engaged in visible conflict and that is in constant contact with the civilian population. The PM is subordinate to the military, making its organization highly hierarchical and adopting military practices and procedures.<sup>11</sup> The training is organized like boot camp, preparing for war instead of civil policing.<sup>12</sup> Furthermore, crimes committed by militarized police officers are not dealt with by the civil justice system, but by military justice; a process that "weaken[s] the rule of law, extends the impunity and violence of the military police in dealing with the civilian population and indirectly assures them wide latitude for arbitrary behavior."<sup>13</sup>

All of this constitutes what Jorge Zaverucha calls an "institutional hybrid,"<sup>14</sup> in which public safety becomes militarized, defined by a military discourse and dealt through military tactics. In Brazil, public safety is still understood through the prism of the ideologically legitimized violence of the old military dictatorship, but now the war on crime has replaced the war against subversives. The police, the media and politicians use the war discourse, referring to a "war on drugs" or a "war on crime." This discourse helps shape the criminal into an enemy that needs to be eliminated and legitimizes a "by any means necessary" position.<sup>15</sup> As Benoni Belli states:

*From what it appears, the military organization of the PM reinforces the ideology of the delinquent as enemy, since at the police officer enters an organization that trains for war. The deaths, which should be discouraged, are calculated as acts of bravery, with little consideration that the confrontation could have been avoided with some kind of negotiation. There is no space for negotiation in the battlefield.<sup>16</sup>*

These acts of bravery are rewarded either through promotion or salary increase.<sup>17</sup>

It is from within this institutional framework that the abuse of violence by the police is internally legitimized. In 2007, the police in Rio de Janeiro killed at least 1,260 people and "all were officially categorized as 'acts of resistance' and underwent little or no serious investigation."<sup>18</sup> The number is even more alarming because on average the number of estimated police homicides is more than double the number of reported police homicides.<sup>19</sup>

### **THE POLICE INSIDE THE FAVELAS**

Abuse of violence by the part of the police reaches its highest extremes inside the favelas. Because of the presence of drug traffickers, the favelas are perceived as the locus of crime and violence in Rio. Even though only 1 to 3 percent of the population in these areas is involved in drug trafficking, police operations effectively target all residents.<sup>20</sup> As Amnesty International reports:

*Policing in Rio de Janeiro continues to be characterized by large-scale operations in which heavily armed police units 'invade' favelas only to pull out once the operation has been completed. [...] Damage to property and infrastructure, the closure of businesses and curfew-like conditions preventing people from*

*going to work and studying, impose financial and social costs long after the operation is over.*<sup>21</sup>

These sweeping actions are justified by blurry distinctions between criminals and residents. As an example, “marginal” is a term commonly used to refer to criminals but that is also used pejoratively against favela residents. Marginal is an example of all-encompassing categories that fail to distinguish between very different groups. It associates criminality to poverty and encourages the same methods – violence and repression – to deal with what in turn are very different social phenomena. Through this use of language the drug dealers and the poor become one in the same.

Favelas and their residents have always been defined as social problems lacking in material goods and civility. This view constructs these populations as dangerous and criminal; a homogenizing perspective of what is actually a very heterogeneous environment.<sup>22</sup> The general view of the favela is that it is located in the fringes of modernity. Small unpainted houses, visible wiring illegally sucking electricity from other areas, narrow and unorganized streets, precarious sewage system and high population density all contribute to the image of the favela as a space between civilization and nature; a place where violence is inherent.<sup>23</sup> When the PM carries out its aggressive operations inside the favelas it reproduces the image of the favela as a wretched environment. When the media describe shootouts and release the number of casualties it provides the rest of the city with an image they can oppose themselves to: the asfalto is civilized while the morro is primitive. The upper classes adopt a perverted Hobbesian perspective<sup>24</sup> in which favela residents are located

in a degenerated state of nature and in a constant state of bellum omnium contra omnes. The issue, however, is that in this context the violence does not actually occur in a “state of nature.” Much of it is actually conducted by “civilization” – by the Brazilian State.

#### **BOPE: THE EMBODIMENT OF TERROR**

The Special Police Operations Battalion (BOPE) functions as an agent of terror on behalf of the State. The BOPE is the elite force of the PM and is infamous for its widespread use of torture, disrespect for human rights and summary executions.<sup>25</sup> It was created to invade enemy territories, not for policing.<sup>26</sup> Its status as an elite force serves as a justification for its violent character. Whereas the conventional police in Brazil – the PM, PC and PF – are considered to be very corrupt, the BOPE is seen as incorruptible. Elite da Tropa, a fictionalized<sup>27</sup> account of everyday life inside the BOPE, provides some insight as to why incorruptibility is such an important theme in the organization’s ethics:

*What is the antidote for the corruption? In the BOPE’s history, the answer was only one: pride. Personal and professional pride. Respect for the black uniform. Death before dishonor. The selection process was so difficult and painful, the initiation ritual was so dramatic, that belonging became the most precious good. Being a member of the BOPE, sharing that identity, converted into the most valuable endowment. The self-esteem is priceless. Therefore it is nonnegotiable.*<sup>28</sup>

Police morality and high-mindedness nurture cohesion and justify the use of excessive force.<sup>29</sup> This is an even stronger factor inside the BOPE, whose training course is permeated with hazing and humiliation. The process is so intense

that only 14 out of 58 candidates graduated out of an August 2008 training course.<sup>30</sup> The result of such a process is high levels of unity and pride within the group. The group sees itself so highly that it refers to other police forces as *pés-de-cão* (dog's feet) and is highly critical of their corruption.<sup>31</sup>

Images of terror are pervasive throughout the BOPE's symbols. Its logo, which stamps the organization's uniforms and vehicles, is a skull with a knife going through the top superimposed over two crossed handguns. The message is clear: they are carriers of terror and death. This message is reinforced by the word used to refer to BOPE officers: *caveira* (skeleton). Terror is also explicit in the exercise songs the officers sing:

<i>Homem de preto, Qual é sua missão? É invadir favela</i>	<i>Man in black What is your mission? It's to invade favela[s]</i>
<i>E deixar corpo no chão. Se perguntas de onde venho E qual é minha missão Trago a morte e o desespero, E total destruição.</i>	<i>And leave bodies on the ground If you ask where I come from And what is my mission I bring death and desperation, And total destruction.<sup>32</sup></i>

The "black" refers to the uniform, which distinguishes them from the ordinary police and at the same time gives them a death squad aspect. Also, in the songs there is no distinguishing between criminals and innocent people; the objective is to spread terror and death throughout the favela. Since the BOPE acts almost exclusively inside the favelas the upper classes are not affected by these images of terror.

A BOPE instrument that has grown notorious is the *caveirão* (big skull) – "a security van that has been adapted into military-style

assault vehicle," including a rotating turret.<sup>34</sup> The government claims the *caveirão* is used to police the favelas and protect officers in dangerous missions. However, favela residents have reported several abuses, such as random firing and torture inside the vehicles. Whenever the *caveirão* starts roaming through the favela, intimidations such as "We have come to take your souls"<sup>35</sup> are issued through its loudspeakers. For the favela resident, the *caveirão* is literally a vehicle of terror announcing its presence to all those it might encounter, regardless if they have broken the law or not. The *caveirão* has become such an agent of terror that it has colonized the imaginary of favela residents. In children, "the innocent fear of the 'bogyman' has been replaced by that of the *caveirão*."<sup>36</sup> Thus, state terrorism proves to have a pervasive effect – by entering the subconscious it ceases to be just a then and there experience and acquires a supernatural character impossible to evade. Even when there is no conflict involving the police or drug dealers, the resident is always living with the fear that something could happen at any time.

## THE EFFECTS OF VIOLENCE AND TERROR IN THE FAVELAS

The violence and terror employed inside the favelas have tangible effects. People who live in the favelas are already alienated from the political process because of the poverty and social exclusion they experience. Because the political world is inaccessible to them, many withdraw into the private sphere and internalize a sense of inferiority.<sup>37</sup>

Violence has made matters worse. When she returned to Rio in 2001 to relocate the people she had studied and reassess the findings of her 1976 book *The Myth of Marginality: Urban Poverty and Politics in Rio De Janeiro*, Janice Perlman discovered that what

had changed the most in favelas was a drastic increase in fear.<sup>38</sup>

*This fear diminishes the use of public space, leads to less socializing among friends and relatives, fewer memberships in community organizations, less sense of trust and less networking. [...] People feel trapped between the drug dealers and the police. They feel the police does more harm and provides less help than the drug dealers, but see both as disrespectful of life in the community.*<sup>39</sup>

This argument is supported by the fact that membership in resident's associations has fallen from 28 percent in 1968 to only 3 percent in 2001.<sup>40</sup> The fact that the police are just as feared as drug dealers – if not more – is indicative of their problematic presence. For favela residents they are not part of the solution, but an essential component in creating a space of terror.

The space of terror in the favelas is so pervasive that it functions as a barrier to combat that terror. When residents from a favela allied with Amnesty International and other groups to organize a campaign against the caveirão, fear was the main obstacle to acquiring a large number of signatures and significant participation.<sup>41</sup> Terror proves to be such an efficient tactic because it is difficult to get through the fear and develop forms of challenging it. The transformation of favelas into spaces of terror serves as a restraint against the political mobilization of residents from those areas. Whereas social exclusion from the outside prevents favela residents from being assimilated into political life, fear serves as a deterrent against internal organization and mobilization. Perhaps the most telling insight comes from an interview Hélio Luz, a former chief of the PC in Rio, gave in the documentary *Notícias de uma Guerra Particular*:

*The police are corrupt. I mean: the institution that exists is an institution that was created to be violent and corrupt. And people question: "Why was it created to be violent and corrupt?" The police was made to provide security to the state and the elite. I work with a politic of repression in benefit of the State for the protection of the State.*<sup>42</sup>

The argument that police works in benefit of the "elite" is supported by the way the different ways it interacts with the lower and upper classes:

*Burglaries are well investigated when upper-class residences are robbed. Upper-class people may pay the police for having stolen property returned; they may also ask the police to 'be tough' (to torture) to get information. However, burglaries of poor people's homes tend to be ignored.*<sup>43</sup>

When combating crime the police works for the interests of the upper classes, and by spreading terror throughout the favelas it functions as a RSA. The police organization is required to maintain the control of political and economic forces in the hands of the upper classes. But even if that is so, how are tactics such as torture and summary executions – tactics usually condemned in democratic and open societies – legitimized?

## **IDEOLOGICAL STATE APPARATUSES AND THE LEGITIMIZATION OF VIOLENCE**

Althusser proposes a basic difference between Repressive State Apparatuses and Ideological State Apparatuses: "The Repressive State Apparatus functions 'by violence,' whereas the Ideological State Apparatuses function 'by ideology.'"<sup>44</sup> The police in Brazil, and in every State for that matter, are part of the RSA, whereas those institutions considered

to be “outside” of the State – such as the media, the family and religion – are ISAs. According to Althusser, even though these institutions are private they are still subordinate to “bourgeois law.” In Rio, ISAs legitimize an ideology that tolerates high levels of violence against favela residents. The following analysis will concentrate specifically on the role of the media as ISAs.

The first thing that needs to be taken into consideration is that in Rio the “if it bleeds, it leads” mentality is dominant; crime stories are a prominent element in media coverage. However, while newspapers, magazines, television and radio extensively cover crimes committed against the upper classes, crimes against the poor are for the most part ignored.<sup>45</sup> Often crime stories involving upper-class victims take the form of dramatic personal narratives that focus on the life and suffering of the victim and his or her family. The coverage of the death of João Hélio Fernandes Vieites in is useful in illustrating and discussing the issues with this kind of practice.

On February 7, 2007, three young men surrounded a car in Rio in order to steal it. They ordered the people inside the vehicle to get out. Vieites’s mother, sister and a family friend all got out, but the robbers took off before Vieite was able to fully exit the car. As the robbers drove away, Vieite’s head was dragged against the asphalt until he finally died. The event resulted in an outcry from citizens, politicians and the media – the latter playing an aggressive role in demonizing the robbers and portraying the suffering of the victim’s family. The four men involved in the robbery and Vieite’s death were arrested the following day, among them a 16-year-old. Immediately calls for severe punishment, including reducing the criminal age and the legalizing the death penalty, began to appear.

Veja, the weekly newsmagazine with the highest circulation in Brazil, ran articles and editorials on the event portraying Vieite’s family’s pain and calling for harsher methods and penalties against criminals. A week after the crime occurred, Veja ran an article<sup>46</sup> that referred to the men arrested as “monsters” and to Vieite as a “public martyr.” The article mocked those who argued that there are structural roots to criminality and stated that in Brazil it was criminals who decided who lived and who died. There were also photos of Vieite’s family crying at his funeral and of the police holding by the neck two of the men involved in the crime and a third that the story fails to identify, and exposing them to photographers as if they were trophies. The men in the photo fit the stereotype of favela residents: they are young, black and shirtless. Two of them have their eyes censored – a sign of them being underage – and the third’s genital is censored because it was exposed when the photo was taken. The image portrayed by the photograph is clear, these are animals that threaten civilization; they need to be controlled by any means necessary. Veja’s, goal was not to just cover the news – if it were so it would cover the daily murders inside the favelas – but to also influence public opinion in a certain direction. Pierre Bordieu elaborates on the consequences of this practice:

*A perverse form of direct democracy can come into play when the media act in a way that is calculated to mobilize the public. Such “direct democracy” maximizes the effect both of the pressures working upon the media and of collective emotion. The usual buffers (not necessarily democratic) against the pressures are linked to the relative autonomy of the political field. Absent this autonomy, we are left with a revenge model, precisely*

*the model against which the druidical and even political model of justice was established in the first place. It happens on occasions that, unable to maintain the distance necessary for reflection, journalists end up acting like the fireman who sets the fire.*<sup>47</sup>

The treatment of Vieite's death by the media is standard practice in Brazil. Editorials from large publications often try to mobilize public support for harsh measures against criminals, including violating human rights and instating the death penalty. These publications go as far as calling human rights privilege for criminals.<sup>48</sup>

The relationship between the media and the police are a clear example of the perverse interaction between the RSA and ISAs. The media publishes statistics provided by the police, and these are considered to be representative of reality. However, as was previously discussed, police actions are biased toward the upper classes. This results in "statistics overrepresent[ing] crimes in which the victim is upper-class and underrepresent[ing] those in which the victim is working-class."<sup>49</sup> The same is true for those who commit the crimes, with an overrepresentation of crimes committed by the poor. The media reproduces a distorted image of reality that supports the idea of violence being connected to poverty.

### **"TALKING CRIME"**

Another very important aspect that needs to be considered regarding the support of violence in Brazilian society is what Teresa Caldeira calls "the talk of crime."<sup>50</sup> According to Caldeira talk of crime is contagious: one story is usually followed by someone else narrating his or her experience. It also orders the city – what areas and what types of people are dangerous and what interactions

are allowed. When talking crime "the categories are rigid: they are meant not to describe the world accurately but to organize and classify it symbolically."<sup>51</sup> The talk of crime reinterprets violence and tries to create order from what is in itself a disordering act. However, the order created is ultimately one that legitimizes violence:

*The symbolic order engendered in the talk of crime not only discriminates against some groups, promotes their criminalization, and transforms them into victims of violence, but also makes fear circulate through the repetition of histories, and, more important, helps delegitimize the institutions of order and legitimize the use of private, violent, and illegal means of revenge. If the talk of crime promotes a resymbolization of violence, it does not by legitimizing legal violence to counteract illegal violence but by doing the opposite.*<sup>52</sup>

The relationship between the talk of crime among the upper classes and the way the media portray violence is complementary. While the talk of crime consists primarily of personal anecdotes, the media's narrative includes distorted statistics that supposedly represent the reality of the situation. The "objective" representation and the subjective experience reflect each other and reify the idea of criminality and violence being associated with the poor and stemming from the favelas. However, this idea does not correspond with reality – it represents the experience of only one side: the *asfalto*. Talk of crime and the media's portrayal of violence create an environment among the upper classes in which fear ceases to be a natural reaction to violence and becomes the prism through which social problems are understood. The image of favela residents is slowly constructed into

that of savage criminals, and that legitimizes violence against them.

### CONCLUSION

In a country where the top one percent of the population earns more than the lowest 50,<sup>53</sup> different forms of control must be exerted so that the structure of inequalities can remain stable. Through repression the State “enables the ruling classes [...] to ensure their domination over the working class.”<sup>54</sup> In Rio the police are an essential component to the RSA. They do not work only to fight crime; the violence they use has the political function of preserving the status quo of inequalities. As Luz explained: “How do you keep two million inhabitants, who earn 112 Reais,<sup>55</sup> when they do, under control? How do you keep all the underprivileged under control, calm? With repression.”<sup>56</sup> The violent character the police take inside the favelas is not accidental, since the most pervasive form of repression

is terror. As Michael Taussig notes, massive populations are controlled through the cultural elaboration of fear.<sup>57</sup> Fear inhibits any significant form of resistance to the existing order from all sides. Inside the favelas people have internalized a sense of exclusion and are too scared to organize themselves. In the urbanized areas people experience violence through a specific narrative in which the locus of the problems is the favela. The favela is perceived as a place to be feared and to be dealt with by the harshest methods – any other alternative would risk enabling criminals. The upper classes support violence by the part of the State because they see it as a form of containing spaces of terror to the favelas. Fear, which exists both inside and outside the favelas in different forms, serves as a powerful insulator against any significant change in the unequal structures of society.

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# Change in Affect as a Function of Extraversion and Stress

## *Monitoring Daily Life With a Daily Mood Diary*

Imagine your typical day including how you felt when you woke up, if you felt social and in high spirits throughout the day or if you experienced anxiety, stress, or feelings of despair. What influenced your mood? Did factors exist that caused a shift in your mood, an argument or a looming deadline? Most importantly did your mood affect social interactions or job satisfaction? Daily events drive our emotional states, thus affecting our behaviors. Identifying the determinants of mood has implications in our everyday lives and field of psychology. By understanding the predictors of mood we can more effectively assign coping strategies, create programs to combat mood-related disorders, and increase self-awareness of mood and their effect on our work and social structures. The current study extends the research on mood correlates to examine the relationship between extraversion and stress on daily mood.

Psychologists have comprehensively investigated factors related to mood fluctuations; however most of this research was conducted

in a laboratory setting. Such research conditions only allow minimal assessment opportunities such as before, during, and after a stressful event such as surgery or an exam. The A-State scale of the State-Trait Anxiety Inventory,<sup>1</sup> an index of transient anxiety, is the most commonly used measure of affect in this research. Such research consistently reveals that anxiety increases as the participant approaches the stressor, remains high during the event, and subsides to baseline level afterwards<sup>2</sup>. Although it is important to understand these events and their role in naturally occurring mood fluctuations, they cannot account for normal day-to-day variations in mood. Researchers have attempted to resolve this problem by using diary methods: an intraindividual design in which mood is assessed over several occasions instead of just two or three times.

Daily diary designs are repeatedly utilized in the study of psychological processes such as emotional well-being, self-regulation, self-awareness, and appraisals of social situations.<sup>3,4</sup> Diary methods allow for investigation

of self-reported experiences in their natural context providing useful knowledge over and above information obtained by more traditional designs.<sup>5</sup> The probability of retrospection is radically reduced by minimizing the amount of elapsed time between an experience and the self-report of this experience. Diary studies allow for frequent self-reports on the events and experiences of participant's daily lives to be obtained. These self-report instruments provide the means to examine social, psychological, and physiological processes within everyday situations, including personality processes<sup>6,7,8</sup> marital and family interaction<sup>9,10</sup> physical symptoms,<sup>11</sup> and mental health.<sup>12</sup> Limitations of diary methods are also worth discussing. Some studies require detailed training sessions for participants. Another is the difficulty in achieving the level of participant commitment and dedication necessary for daily diary assessment. Habituation is also a problem when the study asks the participant to answer the same questions in the same order for weeks at a time.

In past research mood was often assessed using a 7-point scale of good versus bad mood whereas daily life events were placed in broad categories such as pleasant or unpleasant. Through this model it has been widely concluded that events strongly influence an individual's daily mood level.<sup>13,14,15</sup> Other research correlated intraindividual mood fluctuations with specific types of life events.

Even when categorization of events was more differentiated, conclusions were limited to mood assessments using a single scale. By characterizing mood by two dominant dimensions, called Positive Affect (PA) and Negative Affect (NA), it is possible to obtain distinctive correlates of mood. Clark & Watson dutifully explain PA and NA.<sup>16</sup> Briefly,

high PA is best characterized by words expressing energy and pleasurable experiences such as *active, excited, alert, enthusiastic, and strong*. Low PA is most clearly defined by words expressing fatigue, such as *sluggish and drowsy*. Conversely, NA is best characterized by words that represent the extent to which a person is feeling upset or unpleasantly aroused. For high NA such words as *distress, nervous, angry, guilty, and tense*, whereas words such as *calm and relaxed* represent low NA.

When positive and negative moods are assessed separately, instead of PA versus NA in a single rating scale, they are more adequately related to pleasant and unpleasant events.<sup>17,18,19,20,21,22</sup> The occurrence of pleasant events and not the occurrence of unpleasant events are related to PA; whereas NA is related only to experiencing negative events. When events are categorized more explicitly, the two dimensions have characteristic correlates: PA is related to trait measures of Extraversion (E) or Positive Affectivity (PA); in contrast, NA is associated with trait measures of Anxiety, Neuroticism, or Negative Affectivity (NA).<sup>23,24</sup> Furthermore, PA is related to measures of social activity such as attending or participating in sporting events and NA is associated with physical complaints and poor mental health.<sup>25,26,27,28,29,30,31,32,33,34,35,36</sup>

Clark and Watson's daily diary research investigated relationships between life events and mood.<sup>37</sup> They particularly examined common events and their relationship to positive affect and negative affect. Their research found high PA was related to social activity, whereas NA was unrelated. The importance of assessing NA and PA independently was determined through their study.

Major recent developments using diary studies aim to explain variability in mood as a function

of daily processes and personality characteristics. Past research has held that extraversion predisposes people to experiencing positive affect and neuroticism to experiencing negative affect.<sup>38,39,40</sup> Through a daily diary, administered at bedtime for eight consecutive nights, David et al. found that neuroticism was associated with both positive and negative daily mood, whereas extraversion was found to be associated with only positive mood.<sup>41</sup> Neuroticism and extraversion were assessed with the NEO Personality Inventory.<sup>42</sup> The NEO-PI (Form S) consists of 181 items answered on five point scale. Their findings show that undesirable events were stronger predictors of negative mood than were desirable events, but the relative impact of undesirable events were smaller when predicting positive mood. This provides evidence that supports a model that treats the positive and negative affect systems as distinct but interconnected. Later, Clark & Watson determined that PA and NA should be studied independently as NA had no relation on social activity whereas PA had a large relation.<sup>43</sup>

Diary methods have also been used in recent research studying the effects of stress on mood states. Research examining how stress at work affects mood related daily changes in both workload and social interaction with co-workers and supervisors to daily mood and health complaints.<sup>44</sup> Results show that an increase in job stress is associated with a same-day decrease in physical and psychological well-being.

In a review of the association of daily stress with mood, day-of-the-week is shown to have an influence on mood.<sup>45</sup> Regardless of how stress and mood are measured there is a same-day association between stress and mood.<sup>46</sup> However, only those participants with strong stress-mood

relationships produce the overall association. Earlier research assessed the influence of daily stress on mental health, specifically negative mood. Daily stress explained up to 20% of the variance in mood. It was revealed that interpersonal conflicts were the most distressing events.

The aim of this study is to determine variability in affect as a function of stress and extraversion over a two week period. Although previous research found relationships between extraversion and mood, less evidence is available concerning extraversion and daily mood. This study expands on past research by using daily diary methods to assess the correlates of mood several times throughout the day, compared to previous studies of daily mood that only assessed mood only once a day, typically at night. Past research evaluated extraversion with other personality traits, whereas this study hopes to find a relationship between extraversion and stress. Previously stressful events were used in mood assessment whereas in this study daily events were not screened as pleasant or unpleasant. This would ideally mimic life events as they typically occur without looking for particularly stressful experiences. This research will focus on assessing mood during the afternoon and evening on Mondays by using the second time point and third time point on each Monday to create a multiple regression model.

Just as Costa and McCrae found that extraversion was associated with state positive affect it is hypothesized that our results will mimic these findings in daily positive mood. Previous findings show stress associated with increase in negative affect and decrease in positive affect.<sup>48,49,50</sup> On the basis of available evidence, it is expected that through these measures extraversion will only have a relationship with positive

affect and stress will be associated with increases in negative affect and decreases in positive affect during Monday afternoons and evenings. It is hypothesized that a model including both extraversion and stress would mirror these results.

## **METHODS**

### *PARTICIPANTS*

The study consisted of 83 college freshmen (37 men and 46 women) at Carnegie Mellon University, aged 18-25. Most students (N=55, 66.3%) were Caucasian, although a considerable amount (N=20, 24.10%) were of Asian descent. The remainder were Hispanic (N=2, 2.4%), African American (N=2, 2.4%), or other (N=4, 4.8%). Participants were recruited in four separate cohorts (September 2000 and 2001 and November 2000 and 2001). The cohorts began the study in October 2000 (N=24, 28.9%), December 2000 (N=30, 36.1%), September 2001 (N=12, 14.5%). On completion of the study, subjects were paid \$120. The protocol was approved by the Institutional Review Board of Carnegie Mellon University.

### *DESIGN AND PROCEDURE*

Participants were recruited through advertisements in university publications, announcements at social and academic function, and postings around campus. Upon contacting the project office, interested participants received details about the study and then underwent a screening interview to determine eligibility. Those who had no history of chronic mental illness, and no regular medication regimen other than oral contraceptives were deemed in good health and scheduled for the study. During a preliminary session, participants provided written informed consent, completed an intake survey featuring a battery of demographic, psychological, and health practice questionnaires, and

received training in daily monitoring procedures. Participants then began 13-days of ecological momentary assessment.

Each subject was given a palm computer (ThinkPad; IBM Corp., White Plains, NY) to aid in the data collection process. Four times each day (1, 4, 9, 11 hours after waking up), the computer sounded an alarm signaling the participants to answer a series of questions reporting their current affect and stress. This schedule was designed on the basis of pilot studies to capture the diurnal rhythm of mood states.<sup>51,52</sup> Their answers were recorded in the computer's memory and retrieved at the end of the EMA period.

### *MEASURES OF AFFECT AND PSYCHOLOGICAL STRESS*

Mood was assessed at each diary measure by using four negative items associated with two subgroups of negative affect (NA) and eight items associated with three subgroups of positive affect (PA). Mood-select adjectives from Profile of Mood States were chosen. NA subgroups were anxiety (jittery, nervous) and depression (unhappy, sad), whereas PA included subgroups of vigor (active, intense, lively, enthusiastic), well-being (happy, cheerful), and calm (calm, relaxed). Each item was rated on a scale from 0 (not at all accurate) to 4 (extremely accurate) with respect to how much that word reflected how participants felt at that moment. For the purposes of this study, one adjective was chosen to represent both PA and NA. Cheerful is used as a measure of PA and sad is used as a measure for NA.

Psychological stress measures were also obtained at each diary entry. At each moment of assessment, participants reported the extent to which they felt overwhelmed and stressed. A Likert scale was used to

rate the responses. The mean stress score across the entire thirteen days of self-assessment was used as the measure of stress.

*MEASURES OF EXTRAVERSION*

Extraversion was assessed at baseline using a modified version of the subscales from Goldberg's Big Five Scale.<sup>53</sup> Participants were required to indicate how accurately a list of traits (e.g., anxious, extraverted, sad, talkative) reflected how they feel on a scale from 0 (not at all accurate) to 4 (extremely accurate). The alphas for extraversion were .92.

**RESULTS**

*PRELIMINARY ANALYSIS AND DESCRIPTIVE STATISTICS*

Prior to the primary analyses, descriptive statistics were obtained for the independent variables: cheerful and sad. Covariance matrices were obtained to adequately account for multicollinearity between variables extraversion and stress. Out of the 83 participants, five observations were missing, therefore we used 77 participants in data analysis. The Pearson correlation coefficients between extroversion and stress were significant ( $r = .86, p = -.02$ ). Table 1 displays the descriptive statistics for each of the variables in the study. We used an alpha level of .05 for all statistical tests.

*PRIMARY ANALYSES*

Simultaneous multiple regression analyses were conducted to examine the predictive relations between dependent variables, extraversion and stress, and mood on Monday afternoons. Two Mondays occurred during the thirteen day period corresponding to day two and day nine. The second assessment of the day, completed four hours after the participant woke up, was utilized for analysis landing typically between

noon and three in the afternoon. For comparison purposes the third assessment, completed nine hours after waking, was also used representing the time point most closely matching with Monday evenings. Cheerfulness and sadness ratings were taken from these time points on both Mondays.

*EXTRAVERSION AND STRESS AS PREDICTORS OF POSITIVE AND NEGATIVE AFFECT*

Data analysis revealed mixed results. The predictors, extraversion and stress, did not reliably predict positive or negative affect over both Monday afternoons and evenings. However, both extraversion and stress together did show a statistically significant relationship with positive affect,  $R^2 = .07, F(2, 75) = 3.78, p = .03$ , and negative affect,  $R^2 = .09, F(2, 75) = 4.82, p = .01$ , on the first Monday afternoon. Both extraversion and stress together did not, however, show a statistically significant relationship with either positive affect,  $R^2 = .02, F(2, 75) = 1.57, p = .21$ , or negative affect,  $R^2 = .05, F(2, 75) = 2.76, p = .07$ , on the second Monday afternoon. These results were replicated during the third time point with both extraversion and stress reliably predicting positive and negative affect. Table 2 presents a summary of the results from the final analyses for the second time point (Monday afternoons) and the third time point (Monday evenings).

*EXTRAVERSION AS A PREDICTOR OF POSITIVE AND NEGATIVE AFFECT*

As an individual predictor extraversion was only a statistically significant predictor of positive affect on the first Monday afternoon of the study,  $t(75) = 2.34, p = .02$ . Extraversion did not significantly predict positive mood on the second Monday or negative affect across

both Mondays. Examining the third time point revealed slightly different results. Extraversion did significantly predict positive affect only on the first Monday evening, but also predicted negative affect on the first Monday evening. Again, extraversion did not independently predict positive or negative affect on the second Monday evening.

#### *STRESS AS A PREDICTOR OF POSITIVE AND NEGATIVE AFFECT*

Independently, stress was the only predictor to yield a statistically significant relationship with negative affect across both Mondays during the afternoon, day two:  $t(75) = 3.00$ ,  $p = .003$  and day nine:  $t(75) = 2.10$ ,  $p = .04$ . However, it was not a significant predictor of positive affect across both Monday afternoons, day two:  $t(75) = -1.56$ ,  $p = .12$  and day nine:  $t(75) = -.71$ ,  $p = .48$ . These results were replicated during Monday evenings where stress, again, was not a predictor of positive affect across both Mondays. However, stress was only a significant predictor of negative affect on the first Monday evening,  $t(75) = 5.07$ ,  $p < .0001$ .

#### **DISCUSSION**

This is the first study to evaluate the change in affect as a function of both extraversion and stress. To an extent our results confirm previous research and our hypotheses. Extraversion and stress did account for a statistically significant change in positive and negative affect on Monday afternoon and Monday evening but only on day two. Overall, baseline extraversion scores and mean stress levels across the thirteen day study were unable to reliably predict positive and negative affect across both Monday afternoons and Monday evenings. Further examination is necessary to account for the ability of these two predictors to adequately account for positive and negative affect on only day 2, the first

Monday. It is a possibility that on day nine, the second Monday, participants are experiencing habituation since the study asks participants to answer the same questions in the same order daily for two weeks.

Individually, each predictor maintained past research expectations, but again only replicating on day two, not day nine. Specifically, extraversion was positively correlated with changes in positive affect and mean stress positively correlated with negative affect. If one looks at the insignificant relationships between an independent predictor and positive or negative affect it is possible to see patterns discussed in past research. Specifically, stress, although not significant, does display a negative correlation with positive affect and a significant positive correlation with negative affect. The same is true for extraversion, where the predictor is negatively correlated with negative affect and positively correlated with positive affect. The present results emphasize that positive and negative affect do represent distinct, but somewhat overlapping, systems.

The ability of extroversion and stress in determining positive and negative affect on Monday afternoons and evenings has particularly important implications in the field of psychology and the treatment of the mentally ill. The ability to organize and implement program to aid in the creation of coping strategies can be strengthened with better understanding of how different factors affect mood. Intervention and treatment of those suffering from mood-related disorders can also be supported with the results of research on mood correlates.

Although this study addressed extraversion and stress as reliable predictors of mood, there are some limitations that deserve mention. Diary studies require researchers to provide

*Table 1. Means and standard deviations for each questionnaire item*

Variable	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
<b>Mood correlates</b>				
Extraversion	21.82	6.8	3	32
Mean Stress	2.33	1.71	0	7.12
<b>Mood variables</b>				
<i>Day 2 (Time 2)</i>				
Cheerful	1.65	1.08	0	4
Sad	0.37	0.67	0	4
<i>Day 9 (Time 2)</i>				
Cheerful	1.51	1.18	0	4
Sad	0.58	0.89	0	4
<i>Day 2 (Time 3)</i>				
Cheerful	1.85	1.08	0	4
Sad	0.41	0.86	0	4
<i>Day 9 (Time 3)</i>				
Cheerful	1.48	1.13	0	4
Sad	0.48	0.98	0	4

detailed and systematically similar training in completing the daily mood assessments on the handheld device. As previously discussed, habituation is also a problem. It is also difficult to achieve participant dedication and commitment at an adequate level. Participant compliance, although minimized by the use of handheld devices, can be an issue. Crawford et al. (2008) question the ability of diary studies to adequately detect change using POMS-15. Their findings reveal that POMS-15 scales reliably assessed mood changes over time. Our study only utilized a small portion of the POMS-15 measures. We exclusively used one item for PA and another for NA, i.e. cheerful and sad respectively. This may be a factor when accounting for the inability for the results to remain significant across both Mondays. Further research may yield more consistent results if using the entire set of mood-related words.

## CONCLUSION

This study was able to determine

the relationship of affect as a function of extraversion and stress. We explored the hypothesis that participants exhibiting high levels of perceived stress were associated with greater measures of negative affect and lesser measures of positive affect while those participating in greater amounts of physical activity were associated with increased positive affect and decreased negative affect. Extraversion and stress reliably predict positive and negative affect, but not across both Mondays. Results do not confirm previous research, although, independently, extraversion was associated with increased positive affect, it was not associated with decreased measures of negative affect. Stress was associated with increased measures of negative affect, but not significantly associated with decreased measures of positive affect. These outcomes lead us to call into question the amount of affect design has upon these conclusions. Perhaps a study designed appropriately for investigating mood correlates would disclose better substantiated outcomes.

This study attempted to determine the relationship of affect as a function of extraversion and stress. A cohort of 83 1<sup>st</sup>-semester healthy university freshmen underwent 13 days of ambulatory monitoring. Four times daily, participants completed a mood assessment including measures of affect and the extent to which they felt stressed and overwhelmed. The present research explored the hypothesis that participants exhibiting high levels of perceived stress were associated with greater measures of negative affect and lesser measures of positive affect while those exhibiting greater measures of extraversion were associated with increased positive affect and decreased negative affect. Multiple regression analyses were used to examine this hypothesis.

Inconsistent with prior research, stress did not predict increases in negative affect; however extraversion did seem to play a role in predicting positive affect.

These findings call for further research investigating the role of extraversion and stress on predicting mood.

Table 2. Summary of the Results from the Final Analyses for the Second and Third Timepoints

Affect	<i>F</i> (2,79)	<i>p</i>	adj. <i>R</i> <sup>2</sup>
<i>First Monday (Day 2) Afternoon</i>			
Positive	3.78	0.03	0.07
Negative	4.82	0.01	0.09
<i>Second Monday (Day 9) Afternoon</i>			
Positive	1.57	0.21	0.02
Negative	2.76	0.07	0.05
<i>First Monday (Day 2) Evening</i>			
Positive	3.57	0.03	0.06
Negative	15.29	<.0001	0.27
<i>Second Monday (Day 9) Evening</i>			
Positive	1.06	0.35	0.002
Negative	0.4	0.67	-0.02

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# The Role of Fucose in Early Cancer Detection

## INTRODUCTION

In many disease states, biological changes occur that indicate disease progression. For example, protein from cancer patients is commonly observed with an increased amount of the sugar fucose. Fucose levels are often elevated even before cancer symptoms are present; thus, fucose is an important indicator that a patient has cancer. The goal of this research is to develop a simple test for fucose levels to assist with early detection of cancer. This research involves preliminary tests to detect fucose at very low levels. These rapid methods could potentially be used in clinical tests for patients who are at risk. Two instrumental methods are also described, which provide sensitive and accurate quantitative results to verify the rapid methods.

## BACKGROUND/METHODS

Diagnosing cancer in the early stages can be vital for improving patient treatment and survival rates. Significant research shows that biomarkers, or indicators of certain

biological states, can be used to determine when cancer is present or has metastasized.<sup>1</sup> Biomarkers like fucose are often detectable at the very early stages of cancer,<sup>2</sup> so investigating these biomarkers is a growing field that is beneficial to patients at all stages of cancer diagnosis and treatment. Thus, the goal of this project is to develop quick, simple methods for detecting and quantifying fucose. These biomarker detection techniques can hopefully be applied beyond the laboratory and in a clinical setting, where a quick and easy method to determine fucosylation is vital to cancer prognosis.

Proteins in the human body undergo numerous changes after they are produced in the cells. Glycosylation, or the addition of sugars to proteins, is ubiquitous in human proteins. Protein glycosylation is important for regulating cellular signaling, cell differentiation and has proven to be a biomarker for certain disease states.<sup>3,4</sup> Changes in glycosylation occur in a variety of diseases, ranging from cancer to cystic fibrosis.<sup>5</sup> For

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example, elevated fucose levels on glycoproteins is linked to human hepatocellular carcinoma and even breast cancer.<sup>6,7</sup> Measuring changes in fucosylation is a vital diagnostic tool for early cancer detection; changes in sugars often occur before cancer has fully developed.<sup>8</sup>

Four analytical techniques were utilized to study and quantify fucose. The group investigated two common color-change reactions for detecting sugars. Colorimetric indicators are useful because the amount of sugar in a sample can easily be visualized without extra equipment. The first rapid method uses phenol and sulfuric acid. When added to a sugar solution, these compounds create a yellow dye; the shade of yellow depends upon the sugar concentration. This reaction was central to the Yellow Card method, in which a yellow scale was designed for visual determination of fucose concentration. Potassium permanganate also reacts with reducing sugars to produce a color change that indicates fucose concentration. This Colorized Reducing Sugar (CRS) test was the second simple method. Two instrumental techniques were also chosen to accurately quantify fucose: High Performance Liquid Chromatography with Pulsed Amperometric Detection and Liquid Chromatography with Mass Spectrometry.

It is necessary to study fucose at concentrations that are biologically relevant to ensure that experiments in the lab would be viable as clinical tests. Although these studies work with pure fucose rather than blood or serum samples, the fucose solutions were prepared based on characteristic fucose levels in the body. The group designated three classes based on fucose levels typical of oral cancer development. A normal, or cancer-free, individual would have fucose levels at 800  $\mu\text{M}$ ; precancerous levels

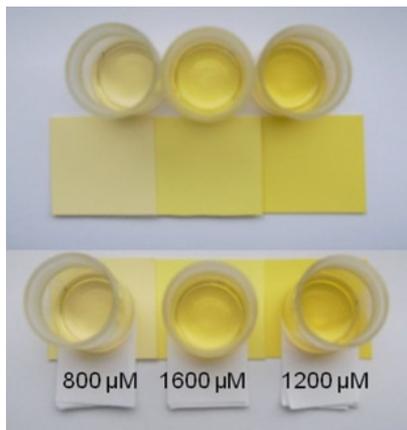
are at 1200  $\mu\text{M}$ ; the threshold for cancer is at 1600  $\mu\text{M}$ .<sup>9</sup> Experiments were designed using this classification system.

All methods were tested in the range stated above for preliminary experiments. Two test samples of fucose were also analyzed by each method. One group member prepared fucose solutions at concentrations of 933  $\mu\text{M}$  and 1314  $\mu\text{M}$ . These samples were regarded as "unknown," as the individuals testing these samples did not know their concentrations. The "unknown" samples were analyzed with each method. Experimental design is described below.

#### *RAPID METHODS*

The simple Yellow Card method is based on the colorization of sugar solutions upon addition of phenol and sulfuric acid. In the reaction, each monosaccharide molecule is dehydrated by the acid, forming a furfural derivative. The furfural derivative then condenses with two molecules of phenol to form a yellow dye molecule. The result is that one molecule of yellow dye is formed for each molecule of sugar in the solution. More concentrated sugar solutions, therefore, produce more intense yellow coloring.

The color change occurs in all carbohydrate solutions, and only a small amount of fucose was available for experimentation, so experiments were performed with other sugars before testing methods on fucose solutions. Galactose is very similar to fucose, so it was chosen for the initial colorization experiments. Galactose solutions in a linear range of concentrations (200  $\mu\text{M}$  to 2000  $\mu\text{M}$ ) were prepared and reacted with phenol and sulfuric acid. The resulting solutions ranged in color from nearly clear to golden yellow. The experiment was then performed on fucose solutions, producing a similar range



of yellow hues. The 800  $\mu\text{M}$ , 1200  $\mu\text{M}$ , and 1600  $\mu\text{M}$  fucose solutions were visibly distinguishable, suggesting that this range of concentrations would be useful for visual distinction between normal and elevated serum fucosylation levels.

To develop the actual Yellow Card, fucose solutions of 800  $\mu\text{M}$ , 1200  $\mu\text{M}$ , and 1600  $\mu\text{M}$  concentrations were reacted with phenol and sulfuric acid in identical vials, and their yellow hues were matched to color swatches from paint manufacturers. A pale yellow color matched the 800  $\mu\text{M}$  solution and two darker shades of yellow matched the 1200  $\mu\text{M}$  and 1600  $\mu\text{M}$  solutions. These three colors are included in the tricolored “Yellow Card” and serve as references when estimating fucose concentrations (Figure 1).

The Colorized Reducing Sugar (CRS) test utilizes an oxidation-reduction reaction in which the sugar’s aldehyde group is oxidized to a carboxylic acid and permanganate is reduced to manganese. Permanganate is purple in solution, while manganese is colorless. Solutions are colorized by the permanganate indicator, but each molecule of sugar in the solution removes some of the purple color. The color of the resulting



Figure 1. (left) Fucose solutions after treatment with phenol and sulfuric acid are placed on white backgrounds and can be seen to match the correct sections of the Yellow Card. The colors included in the tricolored care are, from left to right, Honey Pot (ACE), Yellow Brick Road (ACE), and Citrus (Behr).

Figure 2. (above) Fucose, 15 $\mu\text{L}$  Indicator; 800 $\mu\text{M}$ , 1200 $\mu\text{M}$ , 1600 $\mu\text{M}$  left to right, 30 min.

solution, therefore, depends upon concentration of the sugar. The 800 $\mu\text{M}$  fucose solution produced a maroon color, 1200 $\mu\text{M}$  fucose solution produced a burnt-orange color, and 1600 $\mu\text{M}$  fucose solution produced a caramel-brown (Figure 2).

Multiple sugars, including glucose, mannose, and galactose were tested as model systems for fucose. These were analyzed in the same concentration range and the same method was used as was used with fucose. All of the sugars produced similar colors when treated with indicator, but the color change occurred more rapidly for some sugars. Mannose reacted the fastest: the 1600 $\mu\text{M}$  sample turned brown within five minutes, then glucose—producing the caramel color in 10 minutes, and galactose was slowest—it required 50 minutes for the 1600 $\mu\text{M}$  sample to yield the caramel color (Figures 3-5).

Variables such as concentration of sugar, volume of potassium permanganate, and time of heating were tested; it was determined that the concentration range that displays a color variation was from about 700 $\mu\text{M}$  to 1800 $\mu\text{M}$  (700 $\mu\text{M}$  being the lower limit of detection). Indicator (potassium permanganate)



Figure 3. Mannose, 20 $\mu$ L Indicator, 800, 1000, 1200, 1400, 1600 $\mu$ M left to right, 5 min.



Figure 4. Glucose, 20 $\mu$ L Indicator, 800, 1000, 1200, 1400, 1600 $\mu$ M left to right, 10 min.



Figure 5. Galactose, 20 $\mu$ L Indicator, 800, 1000, 1200, 1400, 1600 $\mu$ M left to right, 50 min.

volume affected the color change slightly. Solution colors were more distinguishable and darker when higher volumes of indicator were applied (Figure 6). Heating time affected results greatly—reaction rate increased as time on the heat source increased. Optimal results were obtained when fucose solutions were heated for one minute on a 90°C heat source, then removed and immediately treated with the indicator. The color of the resulting solutions changed over time, and it was determined that different fucose concentrations were most distinguishable when observed 20-30 minutes after addition of the indicator. Because the color change occurs for any reducing sugar, only pure fucose solutions were utilized for quantitative experiments.

#### INSTRUMENTAL METHODS

Although the simple methods stated above are quick, they do not have the quantitative capability of an instrumental technique. Thus, to explore more quantitative techniques,



Figure 6. Fucose, 20  $\mu$ L Indicator, left to right: 800  $\mu$ M, 1200  $\mu$ M, 1600  $\mu$ M, 30 minute reaction time. A higher volume of indicator improved the reaction and made the three concentrations of fucose more visually distinguishable.

two instrumental methods were applied that provide sensitive and quantitative results.

High performance liquid chromatography with pulsed amperometric detection (HPLC-PAD) is a highly sensitive method for separating and detecting the components of a solution. This method utilizes an anion exchange column, separating fucose through interactions of its anionic forms with the substrate of the column. Different sugars have varying affinities for the column; thus move through it at different rates, and leave the column at specific times. Knowing these times for fucose allowed for identification and accurate quantitation.

Pulsed amperometric detection (PAD) was used with HPLC to detect fucose electrochemically. Amperometry was used with three electrodes to drive an electrochemical reaction. One of the electrodes is the working electrode, where the electrolysis takes place. The second electrode, the counter electrode, allows for the flow of current by acting as an “electron sink”. For work with pulsed amperometric detection, a third non-polarizable electrode, the reference electrode, was needed so that a comparison between the changes in current could be measured. The change in current corresponded to the concentration of fucose in a

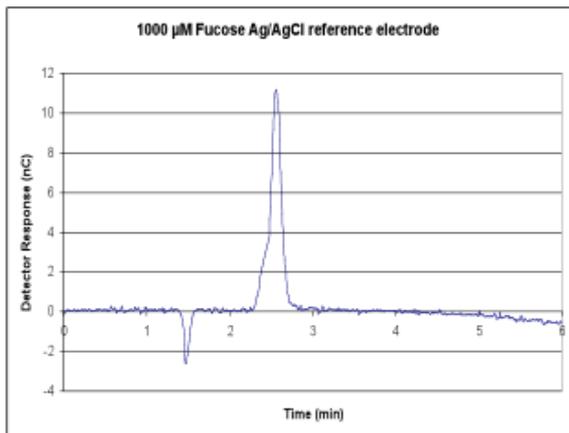


Figure 7. This HPLC-PAD chromatogram depicts 1000  $\mu\text{M}$  fucose, which comes off the amino column at approximately 2.5 minutes to produce the peak.

sample. This method was applied to the samples run on the rapid colorimetric methods to confirm the accuracy of the results.

Quantitation by HPLC-PAD was done using a calibration curve as an external standard. Five fucose solutions (2000  $\mu\text{M}$ , 1000  $\mu\text{M}$ , 500  $\mu\text{M}$ , 250  $\mu\text{M}$ , and 125  $\mu\text{M}$ ) were made by serial dilution. Each solution was analyzed by HPLC-PAD three times, producing chromatograms (Figure 7). Literature relevant to the detection of simple carbohydrates using HPLC-PAD was consulted to select the optimal amperometric conditions. The fucose peak areas from the chromatograms were plotted versus concentration, and linear regression curve was made to fit the data. This produced a standard curve for the extrapolation of concentrations of unknown samples.

Along with HPLC-PAD, liquid chromatography-mass spectrometry (LC-MS) was used to verify the results of the rapid methods. With HPLC-PAD, separation occurs in the liquid phase inside a column. However, with LC-MS, compounds were separated by an amino column. Optimal separation

was produced by a mobile phase containing 60% ACN and 40%  $\text{H}_2\text{O}$ .

Mass spectrometry was used as to identify and quantify fucose after liquid chromatography. MS provides mass-specific information about compounds, which can be helpful for analysis. Utilizing electrospray ionization mass spectrometry (ESI-MS); samples were ionized

with 10 mM ammonium acetate in positive ion mode and detected by the spectrometer. This ionization produced the charge state  $[\text{M}+\text{NH}_4]^+$ . To ensure accuracy, single ion monitoring (SIM) mode was used to exclusively detect fucose and glucose ions.

Two methods were used to determine fucose concentrations by LC-MS. The first method, a calibration curve, related the concentrations of fucose solutions to the peak areas they produced in the LC-MS chromatogram. Fucose standards of 400  $\mu\text{M}$ , 800  $\mu\text{M}$ , 1200  $\mu\text{M}$ , and 1600  $\mu\text{M}$  were run through LC-MS, and their peak areas were plotted versus concentration, producing a calibration curve (Figure 8). Concentrations of unknown samples were found by running them through LC-MS to find a peak area for the solution, then extrapolating the concentration from the calibration curve.

The second method of quantitation utilized a similar sugar, glucose, as an internal standard. A spike of glucose was injected into a fucose standard. A response factor

Figure 8. A calibration curve was made using four standard solutions of fucose ranging from 400  $\mu\text{M}$  to 1600  $\mu\text{M}$  run on the LC-MS. The peak area from LC increased linearly with concentration, as the line suggests. Concentration was plotted versus peak area.

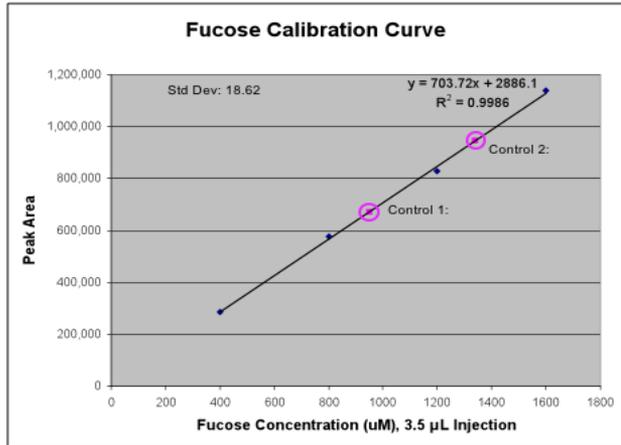


Figure 9. LC-MS chromatogram. Glucose was used as an internal standard for fucose. By spiking in a known amount of glucose, the unknown concentration of fucose could be calculated based on relative peak areas. This particular chromatogram shows an unknown concentration of fucose, which was accurately determined using the internal standard method.

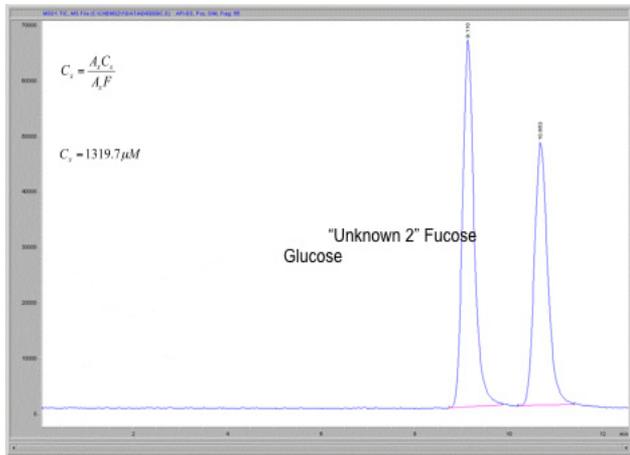
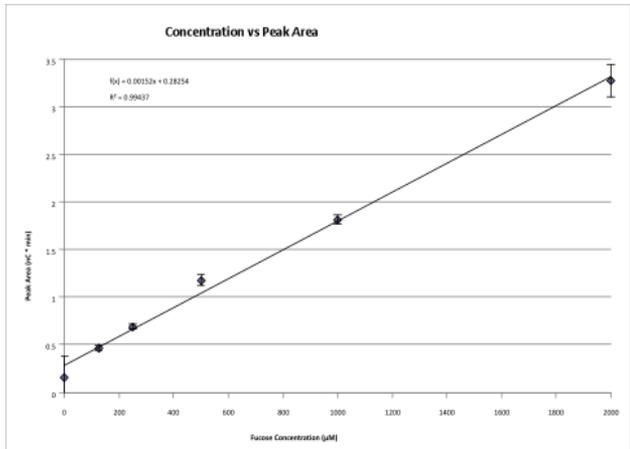


Figure 10. Fucose Calibration Curve prepared by HPLC-PAD. The Calibration curve was produced by serial dilutions of a 2000  $\mu\text{M}$  solution. The curve shows strong correlation between fucose concentration and integrated detector response.



was calculated, which is a way to measure how the instrument responds to the two sugars. The response factor relates the peak areas produced by the two different sugars to their concentrations; this response factor can then be used to calculate an unknown fucose concentration when glucose has been added. Once unknown fucose samples were spiked with glucose and run through the LC-MS, the previously determined response factor was plugged into a formula to calculate the concentration of fucose (Figure 9).

## **RESULTS, DISCUSSION AND IMPLICATIONS**

### *RAPID METHODS*

The Yellow Card and CRS tests were performed on the “unknown” fucose solutions. The Yellow Card method produced estimates of 900  $\mu\text{M}$  for unknown 1 and 1400  $\mu\text{M}$  for unknown 2. The Yellow Card estimates differed by 3.5% and 6.5%, respectively, from the actual concentrations of the solutions (unknown 1 was 933  $\mu\text{M}$ ; unknown 2 was 1314  $\mu\text{M}$ ). The CRS test produced estimates of 950  $\mu\text{M}$  for unknown 1 and 1400  $\mu\text{M}$  for unknown 2, differing by 1.8% and 6.5%, respectively, from the actual concentrations. These results suggest that the Yellow Card and CRS tests are sufficiently sensitive to determine whether fucose levels are normal or elevated.

### *INSTRUMENTAL METHODS*

The fucose concentrations in the unknown samples were calculated to be 888.7  $\mu\text{M}$  and 1227  $\mu\text{M}$  by extrapolation from the HPLC-PAD calibration curve (Figure 10). Both of the instrumentally determined concentrations were within 7% of their actual values.

After fucose standards were run on the LC-MS, two fucose samples of unknown concentrations were

studied. The first unknown gave a fucose peak area of 671042.9, which correlated to  $949.5 \pm 18.62 \mu\text{M}$  from the calibration curve and 970.84  $\mu\text{M}$  from the internal standard. The actual concentration of fucose was 933  $\mu\text{M}$ , yielding calibration curve and internal standard errors of 1.7% and 3.4%, respectively. The second unknown gave a fucose peak area of 945248.6, which correlated to  $1339 \pm 18.62 \mu\text{M}$  from the calibration curve and 1319.7  $\mu\text{M}$  from the internal standard. The actual concentration of fucose was 1314  $\mu\text{M}$ , yielding calibration curve and internal standard error of 1.9% and 0.38%.

From these experimental tests, it was accepted that LC-MS was sensitive enough to quantify the levels of fucose and accurately classify them as normal, precancerous, or cancerous. These results imply that LC-MS produces sufficiently sensitive data to verify the results of the colorimetric methods.

## **CONCLUSIONS**

The two unknown solutions were tested with each of the methods. Results indicate that LC-MS provides the most accurate quantitative results, as error was less than 3.9%. HPLC-PAD was also able to quantify unknown samples with 7% error. LC-MS is useful for quantifying fucose and it provides mass-specific information that could be beneficial for identifying compounds in a biological sample. The two rapid methods successfully identified the unknowns as normal, precancerous, or cancerous levels of fucose. The Yellow Card method is advantageous because it requires no heat and provides a lasting color solution that can easily be identified using the Yellow Card. It is promising for application in a clinical setting because it provides quick, visual results.

Successful classification of fucose levels as normal, precancerous, or

cancerous by both of the rapid methods implies that, upon further development, these methods may one day be applied to a clinical setting. For these experiments, pure fucose was analyzed to verify our proposed methods. Because these simple methods are not selective for fucose, any future experiments mimicking a biological system would also require separation of fucose and/or fucosylated glycoproteins from other sugars in blood or serum.

The results for the instrumental methods and the rapid methods agree. Although the Yellow Card method and the CRS method had high limits of detection, they are still useful methods for the early detection of possibly cancerous or precancerous conditions. Further experimentation could focus

on reducing the amounts of reactants needed as well as modifying the Yellow Card method to require less hazardous reagents.

The next step for the project involves studying model biological systems. Solutions containing both sugar and glycoproteins should be analyzed with each of the methods to more closely mimic a blood or serum sample. This would determine whether the biological matrix affects visualization or quantitation. After studies of model systems, separation of fucose from biological samples, such as blood or serum, could be applied towards a clinical setting after development of additional preparation and purification steps.

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# Neandertal vs. Modern Human

## *A Look at Skeletal Traits*

### **INTRODUCTION**

Since the initial discovery of Neandertals there has been an ongoing debate about their phylogenetic position in evolution. Are they or are they not a separate species from the modern human? In the past, Paleoanthropologists have used metric and morphological differences to validate claims that European Neandertals belong to a different species than modern *Homo sapiens*. Such assertions were based on a compiled list of characteristics considered to be autapomorphous to the European Neandertal. From these so-called “conclusions” a series of speculative evolutionary models came into being in an attempt to explain extinct groups. However, due to the growing number of Neandertal remains, Paleoanthropologists have recently begun to reevaluate the accuracy of the characteristics once thought to be singularly Neandertal. Through the analysis of the Horizontal-Oval (H-O) foramen and the retro-molar space, both occurring on the mandible, I was able to compare the frequency of two purportedly unique

traits among European Neandertals, Early and Late Upper Paleolithic, Mesolithic and modern humans, as well as chimpanzees and gorillas.

### **BACKGROUND**

Neandertals appeared during the Mousterian period lasting from 70,000 B.C.E. to 40,000 B.C.E. when they mysteriously disappeared. One of the main models tackling their disappearance is the Recent African Origins model or Out of Africa. This model argues that modern humans first arose in Africa about 100,000 years ago and spread from there throughout the world. Most important to Paleoanthropologists is the notion that indigenous pre-modern populations in other areas of the world were replaced by the migrating populations with little, if any, hybridization between the groups.<sup>1</sup> According to this model, distinctive regional features of archaic *Homo* species in other areas were not incorporated into modern human populations that eventually replaced them. Therefore no trait considered to be unique to Neandertals should show

up among modern human skeletal remains.

The opposing side to this argument is the Multiregional Evolution model. This model differs from the first by denying a recent African origin for modern humans and instead emphasizes the role of both genetic continuity over time and gene flow between contemporaneous populations in arguing that modern humans arose not only in Africa but also in Europe and Asia from their Middle Pleistocene forbearers.<sup>2</sup> In other words, unique regional features connect modern and archaic humans in each region through derived and retained archaic characteristics.<sup>3</sup> This allows for Neandertal traits to be passed onto modern humans without conflict based on the assumption that the two groups are of the same species. However, the purpose of this paper is not to argue which world-population theory is correct, but rather to look objectively at two traits found in the skeletal material commonly used to support each side of the argument.

The first purportedly unique trait I will look at is the horizontal-oval (H-O) foramen type. This trait is identified by the anterior and posterior borders connected by a broad band of bone which appears to be a posterior extension of the mandibular lingula.<sup>4</sup> When present, the H-O is distinct enough that it cannot be mistaken for bridging of the mylohyoid sulcus, which occurs inferior and anterior to it. Paleoanthropologists have agreed that such a trait is a deviant form of the normal V or U-shaped foramen.<sup>5</sup> This foramen functions as the entrance to the mandibular canal through which the inferior alveolar branch of the mandibular division of the 5th cranial nerve and accompanying vessels pass.<sup>6</sup> Soft tissue, known as the sphenomandibular ligament, surrounding the area has been shown to be responsible for stabilization and

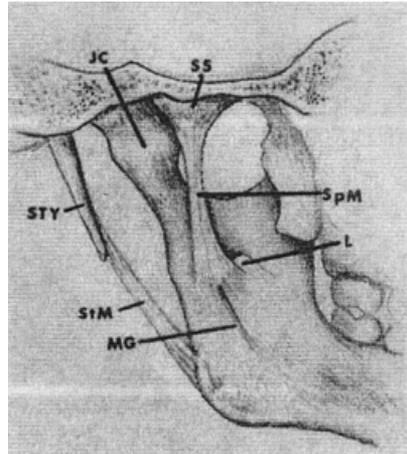


Figure 1. The position of the sphenomandibular ligament (SpM) and other associated structures in man: the lingula (L), spine of the sphenoid (SS), joint capsule of the TMJ (JC), styloid process (STY), stylomandibular ligament (StM), and mylohyoid groove or sulcus (MG) (Smith 1978).

inserts very closely to the mylohyoid sulcus on the interior of the mandible. The ligament attaches the mandible to the underneath of the cranium as seen in Figure 1. Scholars believe that it is probable for the “abnormal” trait to have benefited not harmed the carrier. By expansion of the bony area, the distance between the mandibular and cranial insertion points is reduced creating a more solid anchoring for the ligament. Although modern doctors can make assumptions as to the function based on information gathered during autopsies, reasons for why the trait has occurred in some and not in others is still a mystery.

The second purportedly unique trait I will examine is the retro-molar space. This trait is identified by a space or gap at the rear of the mandible between the back of the [third] molar and the anterior edge of the ascending ramus where it crosses the aveolar margin.<sup>7</sup> Considered to be

one of the more important traits when it comes to separating Neandertals and modern humans as different species, the retro-molar space is seen as a requirement for the midfacial prognathism necessary to maintain the functionality of the upper and lower teeth.<sup>8</sup> An example of this trait can be seen in the Neandertal mandible in Figure 2.

Renewed interest in the H-O foramen type began with the research Smith (1978) carried out focusing on Krapina remains. Of the nine mandibles he examined, three displayed the H-O foramen type. After expanding his sample size to include Near Eastern material he discovered five additional carriers putting the total at 8 individuals out of the 22 examined as seen in Table 1. In addition to Neandertal material he also recorded incidences of the trait on European Upper Paleolithic hominids. Of the ten examined, only Predmosti 3, 4 and Vindija 207 exhibited the trait as seen in Figure 3.

Frayser (1992) expanded on Smith's research by examining greater numbers of European Neandertal remains for the H-O foramen type and looked at trends between Early and Late Upper Paleolithic, Mesolithic

and a set of modern human remains belonging to a group of Medieval Hungarians. Of the groups studied, European Neandertals showed the highest frequency with 10 out of 19 individuals displaying the trait. Among 22 Early and 30 Late Upper Paleolithic individuals the trait presented itself in four and two individuals respectively. In skeletal material dating to the Mesolithic period, three individuals from the total 161 displayed the trait. Additionally, the trait was also discovered in three individuals from the 208 member Medieval Hungarian group. However, the one sample from the Skhul/Qafzeh group and two samples belonging to African "Eves" from Border Cave and Klasier River Mouth, showed no presence of the H-O foramen type as seen in Table 2.

For the Retromolar space, Trinkaus (1987) lists five specimens (Krapina 57, La Nauvette 1, La Quina 9, Vindija 206, and Hortus 4) as lacking the "typical" trait.<sup>9</sup> Despite

Figure 2. (below) Krapina 59 Mandible - Left side

Figure 3 (right) Krapina 63- right Ramus showing clear H-O foramen type.

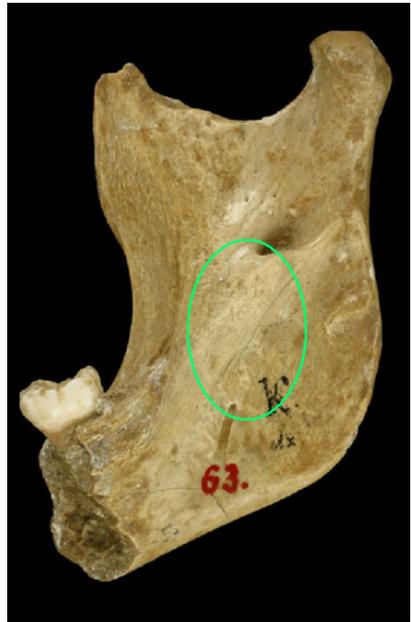


Table 1. Form of the lingula-mandibular foramen area in Neandertals listed by individual specimen. A plus (+) indicates presence of the H-O type. A minus (----) indicates a normal mandibular foramen. An I indicated an indistinct morphology. An X indicates absence of the area on the specimen. Source for observation: (A) original fossil, (B) cast, (C) photograph, (D) personal communication from Dr. T. D. Stewart (Smith 1978).

Specimen:	Source:	Side: Left	Side: R
Krapina 53	A	X	----
Krapina 59	A	+	+
Krapina 63	A	X	+
Krapina 64	A	X	----
Krapina 65	A	X	I
Krapina 66	A	+	X
Krapina 67	A	----	X
Krapina 68	A	+	X
Krapina 69	A	----	X
Teshik Tash (j)	B	----	----
Gibraltar (j)	B	X	----
La Chapelle	B-C	----	----
La Quina H5	B	+	+
La Ferrassie I	B-C	+	+
Le Moustier	B	+	I
Ehringsdorf	B	X	I
Circeo 2	B	X	I
Circeo 3	B	X	I
Tabun I	B-C	----	----
Tabun II	B-C	+	+
Shanidar I	D	----	----
Shanidar II	D	X	----

Table 2. Mandibular foramen types in European Neandertals, Skhul/Qafzeh, Early Upper Paleolithic, Late Upper Paleolithic, Mesolithic and Medieval Hungarians (Frayer 1992)

Specimen:	Horizontal-Oval % (N):	Normal % (N):
European Neandertals	52.6 (10)	47.4 (9)
African "Eves"	0.0	100.0 (1)
Skhul/Qafzeh	0.0	100.0 (2)
Early Upper Paleolithic	18.2 (4)	81.8 (18)
Late Upper Paleolithic	6.7 (2)	93.3 (28)
Mesolithic	1.9 (3)	98.1 (158)
Medieval Hungarians	1.4 (3)	98.6 (205)

Table 3. Recordings of the presence or absence of the retro-molar space according to Trinkaus, Wolpoff, Frayer 1992. A plus (+) indicates presence of the retro-molar space on at least one side. A minus (----) indicates no presence of a retro-molar space on either side.

Specimen:	Retro-molar trait:
Krapina 57	----
La Naulette 1	----
La Quina 9	----
Vindija 206	----
Vindija 207	+
Hortus 4	----
Predmosti 3	+
Predmosti 4	+
Predmosti 21	+
Brno 2	+
Skhul 5	+
Qafzeh	----
African "Eves"	----

expectations of researchers that the retro-molar trait should be absent in Upper Paleolithic hominids, Wolpoff (1981) describes that very trait in the Vindija 207 mandible associated with that time period. Other examples were described in Predmosti 3, 4, and 21, as well as Brno 2.<sup>10</sup> With the exception of Skhul 5, none of the Qafzeh nor any remains attributed to African "Eves" have been found to carry the trait as seen in Table 3.<sup>11</sup> However, all of this research done on Neanderthal and Paleolithic groups would be for nothing, had somebody not collected information for the frequency of these traits in modern human populations.

In 1911, Ohio laws changed to allow professors of anatomy to retain skeletal and other material specimens from the cadavers dissected by their medical students. A year later, T.W. Todd seized this opportunity with his appointment as professor of anatomy to Western Reserve University and began collecting the material.<sup>12</sup> At the time of his death in 1938, the collection contained records

of over 3,600 cadavers and over 3,000 skeletons.<sup>13</sup> These materials were supported by extensive documentation, thus creating the largest modern documented human skeletal collection in the world. Carl Hamann, Dean of the Western Reserve University School of Medicine, was instrumental in assisting Todd in the building of the collection. In addition there are 1,216 specimens in the non-human primate collection. Of these, 967 specimens are represented by cranial or postcranial skeletal remains. Smaller primates were purchased through Gerrard and Sons in London while larger primates were purchased from a private collector.<sup>14</sup> The skeletons in the University's collection were transferred to The Cleveland Museum of Natural History during the 1950's and 1960's. With the opening of the Physical Anthropology Lab at the Museum, this collection has become one of the most researched museum collections in the world and the prime location for carrying out my own research.

#### DATA

Due to the large size of the collection, I pulled ten specimens from each number bracket consisting of 100 specimens in order to get a more varied sample. From there, samples were examined for the presence of intact rami so that the mylohyoid sulcus was clearly visible and a reading of the H-O trait could be taken. If missing or damaged the sample was replaced and another specimen was used. In total 500 human and 100 non-human primate samples were used. During examination of each specimen the left and right side were considered separately. Therefore if a sample displayed the trait on the left but not the right, the presence was still marked.

Readings for the presence or absence of the retro-molar space



Figure 4. HTH 0303 (left) showing the normal V-shaped foramen and HTH 0301 showing the anomalous H-O foramen type.



Figure 5. HTH 183 (left) displaying the retro-molar space and HTH 171 (right) with normal spacing.

were taken concurrently with the H-O analysis. Unfortunately, due to the lack of preservation of the third molars, many of the samples were not able to be used. In total, only 130 human and 75 non-human primate samples met the criteria. During examination, each specimen was rotated 90 degrees so that the ascending and horizontal rami were flat. This was measured by holding a line level on each area to ensure the proper angle. If needed, adjustments were made and each area was re-measured. Once this was done specimens with a noticeable gap were further tested by placing the head of

an unsharpened no. 2 pencil in the area. If big enough to fit, the specimen would be recorded as having the trait. As with the previous trait, the presence of the retro-molar space was also considered separately for left and right sides. In addition, due to the reliance on retained erupted third molars all children were excluded from the study.

The modern human sample used for the study was made up of mainly European-Americans and African-Americans. Although a few Asian-Americans were recorded, they will not be discussed in this paper due to their small proportion in the overall collection. Much like the Neandertals, human specimens carrying the trait are easily detectable in most cases as seen by the comparison of the normal V-shaped foramen with the anomalous H-O type seen in Figure 4. Of the 394 male mandibles studied, 15 European-Americans were found to exhibit the H-O trait, while African-Americans showed much lower frequencies with only three representations found. Noticeably, of the 106 female mandibles examined, European-Americans and African-Americans each contained two representations as seen in Table 4.

Males once again continued to



Figure 6. HTB 1078 (left) gorilla showing the H-O foramen type and HTB 1998 (right) gorilla showing the normal V-shaped foramen.



Figure 7. HTB 1723 (left) chimpanzee and HTB 1072 (right) chimpanzee both showing normal foramens.

display higher frequencies of the retro-molar space than females. Among the 111 male mandibles studied, 49 European-Americans and 19 African-Americans were found to display the retro-molar space. Unlike the H-O trait, the frequency of the retro-molar was higher in African-Americans with seven observed while only one European-American displayed its presence as seen in Table 5. However, it must be brought to one's attention that a total of only 19 females met the criteria to be studied. Similarly to the H-O, observing a positive occurrence of the trait for most specimens was relatively easy due to the size of the gap as seen in Figure 5.

Although not much research has been carried out in the realm of non-human primate research in regards to these traits, the unique

opportunity brought on by the makeup of the collection offered another area of study. In order to keep things simple I applied the same criteria and measuring procedures to 50 gorillas and 50 chimpanzees.

Although orangutan material was available, constraints on time made it impossible to include in my study. Of the 33 male gorillas studied, six displayed H-O traits that looked remarkably similar to those displayed in human mandibles as seen in Figures 6 and 7. None of the 17 females displayed anything resembling the trait. In addition, none of the 20 male or 30 female chimpanzees studied show signs of having the trait as seen in Table 6.

While the H-O trait was stronger in the male primate group, it is the female primate group that seems to



Figure 8. HTB 1723 (left) chimpanzee with retro-molar space and HTB 1072 (right) chimpanzee with normal spacing.

Table 4. Mandibular foramen types in European-American males, African-American males, European-American females and African-American females studied in the Hamann-Todd Collection.

<b>Specimen:</b>	<b>Horizontal-Oval % (N):</b>	<b>Normal % (N):</b>
European-American males	5.3 (15)	94.7 (270)
African-American males	2.8 (3)	97.2 (106)
European-American females	3.8 (2)	96.2 (51)
African-American females	3.8 (2)	96.2 (51)

Table 5. Recording of the presence or absence of the retro-molar space in European-American males, African-American males, European-American females and African-American females studied in the Hamann-Todd Collection.

<b>Specimen:</b>	<b>Retro-molar space % (N):</b>	<b>Normal % (N):</b>
European-American males	71.0 (49)	29.0 (20)
African-American males	45.2 (19)	54.8 (23)
European-American females	20.0 (1)	80.0 (4)
African-American females	50.0 (7)	50.0 (7)

Table 6. Mandibular foramen types in Gorilla males, Gorilla females, Chimpanzee males and Chimpanzee females studied in the Hamann-Todd Collection.

<b>Specimen:</b>	<b>Horizontal-Oval % (N):</b>	<b>Normal % (N):</b>
Gorilla males	18.2 (6)	81.8 (27)
Gorilla females	0.0 (0)	100.0 (17)
Chimpanzee males	0.0 (0)	100.0 (20)
Chimpanzee females	0.0 (0)	100.0 (30)

Table 7. Recordings of the presence or absence of the retro-molar space in Gorilla males, Gorillas females, Chimpanzee males and Chimpanzee females studied in the Hamann-Todd Collection.

<b>Specimen:</b>	<b>Retro-molar % (N):</b>	<b>Normal % (N):</b>
Gorilla males	27.8 (5)	72.2 (18)
Gorilla females	35.3 (6)	64.7 (11)
Chimpanzee males	6.7 (1)	93.3 (14)
Chimpanzee females	15.0 (3)	85.0 (17)



Figure 9. HTB 1717 (left) gorilla with retro-molar space and HTB 1930 (right) with normal spacing.

display stronger frequencies of the retro-molar space. Of the 16 gorilla females studied, six showed clear signs of the trait. Similarly, of the 20 female chimpanzees studied, three display the trait as seen in Figure 8. Five out of the 15 male gorillas also exhibited the retro-molar space as seen in Figure 9. Only one of the 15 male chimpanzees carried the trait seen in Table 7.

## RESULTS

From the data gathered by Frayer and presented in Table 2, it is clearly seen that just over half of the material attributed to European Neandertals (52.6%) exhibit the H-O foramen type. One can also see that while the percentage is much lower for Early Upper Paleolithic hominids (18.2%), it is also clearly distinct from the much lower percentiles seen within the Late Upper Paleolithic (6.7%), Mesolithic (1.9%) and Medieval Hungarians (1.4%). In comparison, data from the Mesolithic hominids and Medieval Hungarians are slightly lower than the modern human material in the Hamann-Todd Collection frequencies. Within those frequencies, European-American males (5.3%) had relatively higher occurrences than European-American females (3.8%), African-American females (3.8%) and African-

American males (2.8%). While no occurrences of the H-O foramen type were found among male and female chimpanzees as well as female gorillas, it is worth mentioning that the frequencies of the trait found within the male gorilla population (18.2%) is equal to the Early Upper Paleolithic hominid frequency. Thus giving the male gorillas found in the non-human primate Hamann-Todd Collection higher frequencies than Late Paleolithic and Mesolithic groups as well as all of the modern humans studied.

From the research done by Trinkaus, Wolpoff and Frayer, there are at least five European Neandertal and six Upper Paleolithic mandibles in existence that display the retro-molar space. Human skeletal material from the Hamann-Todd collection was found to produce relatively high frequency rates. Notably, European-American males exhibited the highest frequency rate at 71%. This was followed by African-American females (50%), African-American males (45.2%) and European-American females (20%). In the Hamann-Todd non-human primate collection female gorillas were found to display the trait more frequently (35.3%) than their male counterparts (27.8%). Likewise,

female chimpanzees (15%) exhibited higher rates than the males (6.7%). Because the overall non-human primate sample size is relatively small, it would be interesting to see if similar frequencies would occur in a larger sample.

In order to test the accuracy of my recordings, I randomly selected 20 human mandibles that had been previously examined and retested them for both the H-O foramen type and the retro-molar space. There were no discrepancies between the first and second reading for the H-O trait. However, the second readings of the retro-molar trait showed three errors. Two of the errors dealt with individuals being read as negative for the trait the first time around but positive the second time. The error occurred on the left side both times. The third error occurred due to a misread in the teeth. After a second look it was recognized that the individual was missing the second molars and possible re-absorption may have occurred thus making the specimen unfit to use in the study. An additional 10 gorilla mandibles were also retested for each trait towards the end of the study. No discrepancies were seen in the H-O foramen readings or the retro-molar space data.

## DISCUSSION

Overall, frequencies found among samples for the H-O trait in modern humans may not have

reached over 10%, however the degree is high enough that it merits further consideration and research. In addition, frequencies for the retro-molar space found among modern human material reached numbers as high as 71 %. Although not much is written on gorilla and chimpanzee morphology concerning the two traits, application of research methods to the non-human primate material returned interesting results and creates new grounds for further questioning and research.

While the debate between Paleanthropologists over the validity of the Recent African Origins model versus the Multiregional Evolution model will continue, one must remember to take non-scientific preconceived notions out of it and look at the hard evidence seen in the skeletal remains. Analyses of mandibles belonging to Upper Paleolithic, Mesolithic and modern humans as well as gorillas and chimpanzees have shown that the two traits discussed are in fact present outside European Neandertals, thus knocking two important characteristics off the list of autapomorphic Neandertal traits that are used to separate them from us. By redefining two major elements of the classification method, the validity of the remaining skeletal traits has been compromised. For now at least, the field of Paleanthropology can remain certain that there is still much to learn and room for growth.

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## The Viability of Cancerous vs. Non-cancerous Cells

Lung cancer is a disease that affects a number of human beings in the world each and every day. It is the number one cancer-related cause of death in men, and the number two cancer-related cause of death in women. It also has a high mortality rate when compared to other cancers. These factors, combined with the high-profile nature of cancer make it imperative that we study this disease and find ways to defeat it. My research with the University of Kansas' High Throughput Screening laboratory is the beginning of finding ways to defeat this disease. Every drug on the market has some mode of action. A compound will bind to a receptor, or block the synthesis of another compound, or act in some way that affects the cell. Here, we are looking for the differences that cancerous and non-cancerous cells have. With this research, we can find compounds that inhibit the growth of cancerous cells, and do not inhibit the growth of non-cancerous cells, and then find common modes of action for those compounds. If there is a common mode throughout many different compounds, then that mode of action can be isolated and further

researched for drug delivery.

In my specific work, we used two different lung cell types: the MRC-5 cell line, which is a normal lung fibroblast, and the A-549, which is a cancerous lung cell. These were not identical cell lines, as they did not originate from the same human being, but they were close matches. The way we decided to approach the problem is to use a cell-based assay to inject the compounds into the cells, and then measure the cells' growth. To find the effects the compounds had on the cells, we needed some way to visualize the viability of the cell lines. To do this, we used the reagent Cell Titer-Glo. This reagent reacts with the amount of ATP present, and luminesces at different intensities corresponding to the amount of ATP. Therefore, if many cells were to survive, the luminescence value would be very high and, contrastingly, if the cells were to die, then the values would be lower. However, before this reagent could be used, preliminary experiments had to be performed.

The first experiment to be performed was to obtain growth curves

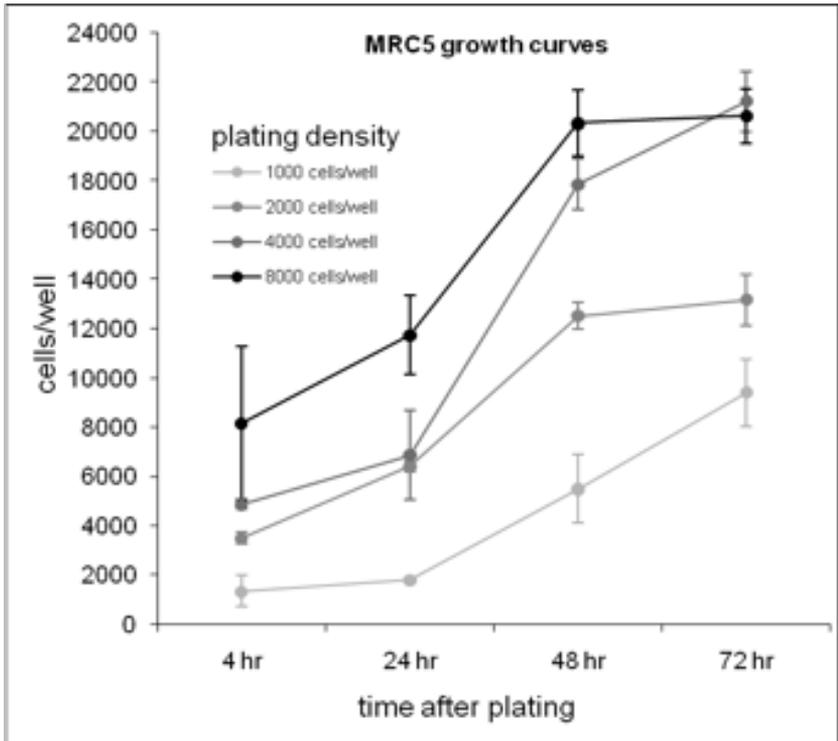


Figure 1. This is the growth curve of the non-cancerous MRC-5 cell line, with an ideal plating density of 1,500 cells / well of a 384-well plate.

for both cell lines. This would allow us to not only find the optimal seeding density for both lines, but to also associate specific luminescence values with specific numbers of cells. This was done by using a hemocytometer to place a specific number of cells within a well of a standard 384-well plate, and using the Cell Titer-Glo reagent combined with the Tecan Safire, 2 a device that measures luminescence values, a luminescence value for that number of cells could be obtained. When that was done, the cells were then plated at specific densities, and allowed to grow. The plates were read with the Cell Titer-Glo reagent every 24 hours, and the luminescence values noted. Since the luminescence

values could only be obtained using black plates, a separate set of cells were plated in clear plates, and using a photographic microscope, a good visual representation of the different densities could be obtained as well. The plates with the higher seeding densities began to show cell death after 48 hours, and the lower seeding densities continued to grow. After the full 4 days of growth, the results showed that the optimal seeding density for both the MRC-5 cell line and the A-549 cell line was 1,500 cells per well. This would allow the cells to grow to full confluency over the four days of the project, but not experience cell death due to overconfluency. If the cells are overly confluent, then they

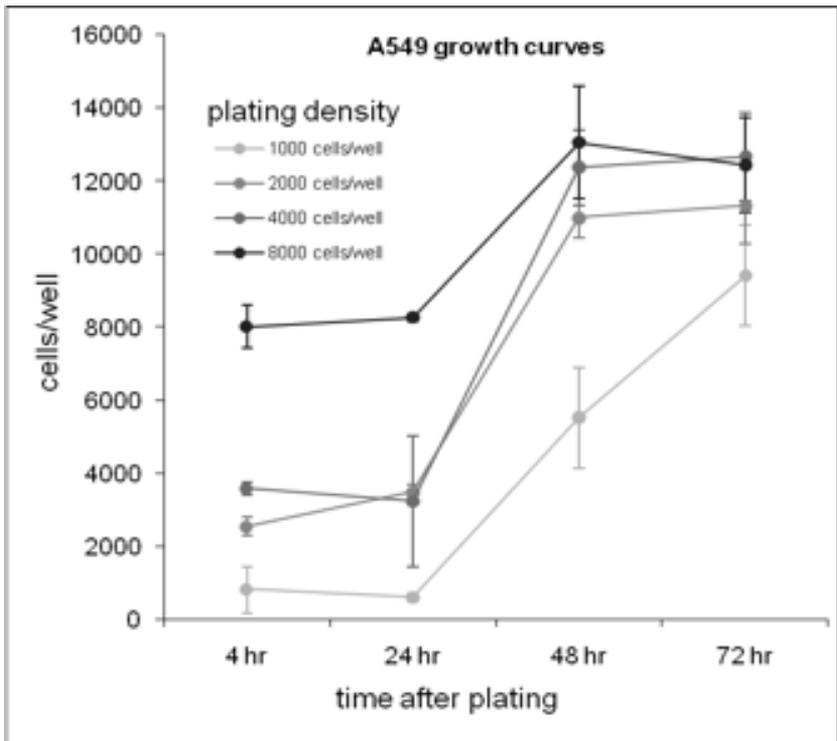


Figure 2. This graph shows the growth curve of the cancerous A-549 cells, which have an ideal plating density of 1,500 cells / well of a 384-well plate.

begin to stack on top of each other, use all of their nutrients, and die in their own waste. This would skew the results of the final project, so it was imperative that we find the proper seeding density.

The second experiment to be performed before the actual assay was a toxicity screen. The compounds used in the screen were stored in 384-well polypropylene plates. The plates contained 20  $\mu$ l of compound



Figure 3. Day 1 of the highest seeding density, 16,000 cells / well of the MRC-5 line

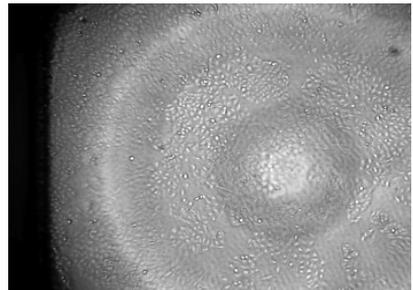


Figure 4. Day 4 of the A-549 1,000 cells / well density, nearing confluency

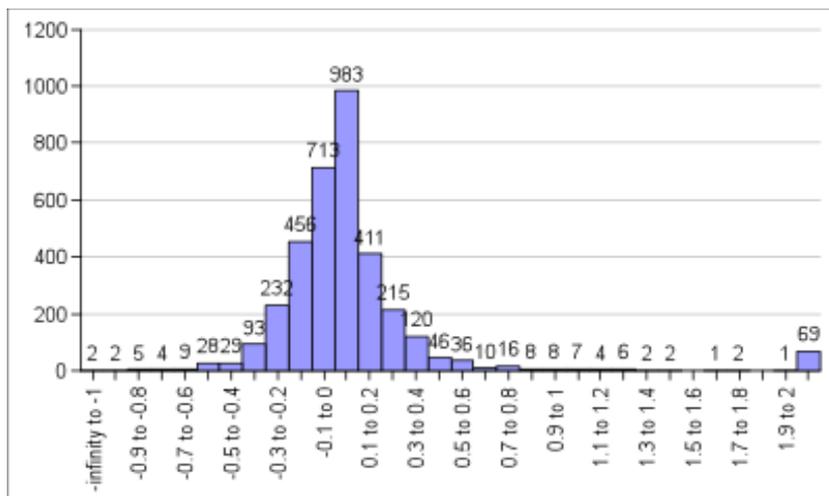


Figure 5. This graph plots the number of compounds vs. their percentages away from normalized values. Overall, there were 79 compounds that were at least 50% below the normalized value, and 103 compounds at least 50% above the normalized value, for a total of 182 compounds classified as "active." Of the 103 active compounds above 50% of the normalized value, 69 of them were of suspiciously high values, and in a concentrated area of one plate, possibly indicating a liquid handling error.

in each well, frozen in 2.25% DMSO in water. Since DMSO is toxic to cells, this test was required to ensure that addition of compound would only induce toxicity due to the effects of compound, not DMSO. By adding different concentrations of DMSO to cell lines, the cell viability was observed by using Cell Titer-Glo and the Tecan Safire2, as in the growth curve experiment. By comparing the luminescence values obtained with the DMSO lines to the growth curve, cell viability was easily established. Since after compound addition, the cells would be in approximately 0.65% DMSO, as long as the cell lines were viable in that concentration of DMSO, then the screen could proceed as planned.

To accomplish this, two black plates were seeded with 1,500 cells per well, one plate of each cell type. This seeding density was found previously in the growth curve experiment. These

plates were allowed to grow for two days, and then, as per the protocol for the final assay, a mock compound was added, using the BioMek FX robotic system. This mock compound was simply a salt solution with different concentrations across the board. After addition, the concentrations of DMSO ranged from 0.0%, all the way to 4.0%. This would allow for reliability of results, and a great range of DMSO toxicity results. After the addition of the mock compound, the cells were grown another two days, and then read using Cell Titer-Glo and the Tecan Safire2. The results showed that for both cell lines, the DMSO concentration used in the final assay was well within safe levels, and that the non-cancerous line did not show signs of toxicity until a concentration of 2%. The cancerous line, however, seemed to be more hardy than the non-cancerous line, not showing signs of toxicity until a concentration of nearly 4%.

After these experiments were performed, the final cell assay could continue. The optimal cell densities had been set, luminescence values could be traced back to actual cell numbers, and the DMSO concentration being used in the final assay was not toxic. The cells were plated at their optimal densities in black 384-well plates, and then grown for two days before compound addition. The compounds used came from different libraries, compiled by different laboratories. The libraries used in the screen were the Prestwick (Prestwick Chemical, Illkirch, France) and the Spectrum Collection (Microsource Discovery Systems, Inc., Gaylordsville, CT) libraries, which contain a very small fraction of the total compounds available to the KU HTS lab. The reason for the small selection of compounds was, again, a time limitation associated with the constraints of an independent study. These libraries consist of small molecules with known biological activity. The purpose of these libraries is to see how compounds with a variety of biological activities behave

in an assay. Thus, their purpose is more for assay development than for finding lead molecules.

After compound addition using the BioMek FX system, the cells were then grown for another two days, to reach full confluency within their wells. They were then read using the same method of Cell Titer-Glo and the Tecan Safire2 seen in the preliminary experiments. After reading the plates, the data was collected, and normalized so that the difference in growth could be easily seen. Again, the point was to find compounds that adversely affected the growth of the cancerous cell line, but caused no harm to the non-cancerous cell line. For a compound to be classified as "active", there needed to be a difference of at least 50% in the growth of the two lines. The data was then analyzed to find the compounds that differed by at least 50% in growth, and the specific compounds noted.

The screen indicated 182 compounds of interest that should be investigated further, as their effects differed by more than 50%.

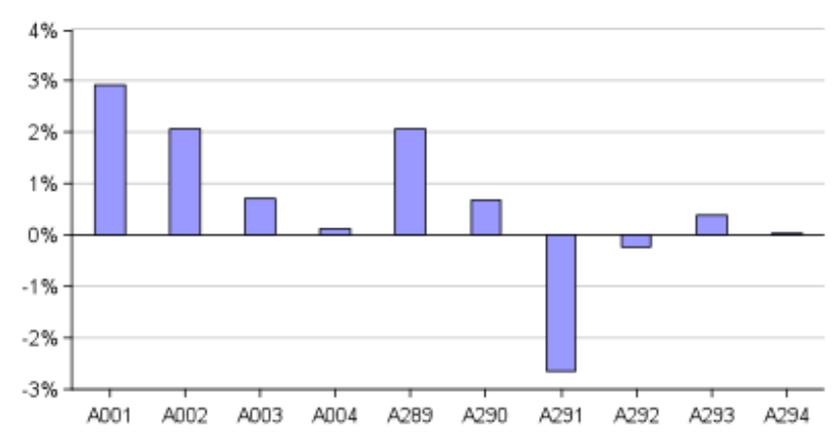


Figure 6. This graph shows the overall effect of certain plates on the cell lines. A positive number means that the plate had an effect that caused toxicity in the cancerous cell line more than the normal cell line, and a negative number means that the normal cell line was more affected than the cancerous line. Plate A001 had a number of abnormalities that could have caused the plate to look as if was more toxic to the cancerous cell line than it actually was.

Unfortunately, due to the time constraints of a student independent study, this work will have to be continued at a later date. The next step with these compounds is to confirm their activity, and ensure that they are not false positives / negatives. Unfortunately, many false positives / negatives are expected during the checks, as there were pipetting errors with the robotic addition system used in the experiment. The next step includes performing the experiment again in the areas that were deemed problematic, and comparing those results against the original results to find false positives and negatives. Compounds that are confirmed as active should be used in dose-response

experiments, to show the potency of the compounds. After dose-response curves have been calculated, the compounds should be used in other assays to determine the mechanism of action for the drugs. There are a number of assays to perform with the drugs, such as apoptosis assays, cell-cycle arrest assays, and cytoskeletal assays. Once the mechanism of action is determined, the compounds can be used with toxicity mechanisms to develop new drug targets. Despite this being only the first, small step in fighting cancer, hopefully we can soon find a way to make these compounds deliverable to human beings, and eventually help those in need.

# Program Evaluation of a Pediatric Oncology Camp For Patients and Siblings

Approximately 12,400 children and adolescents in the United States are diagnosed with cancer each year.<sup>1</sup> As a result of recent medical advances, death rates for childhood cancer have decreased significantly in the past several decades. However, the importance of addressing challenges faced by children with cancer, such as social impairment or elevated levels of distress still remain critical.<sup>2</sup> Childhood cancer greatly affects the family members of the child who is diagnosed. For example, siblings of chronically ill children are at an increased risk for developing mental health problems such as anxiety or depression.<sup>3</sup>

In addition to other psychosocial interventions, one response to the number of children and adolescents affected by chronic illness has been to develop therapeutic recreation camps. The goals of such camps vary from increasing disease-related knowledge to improving self-esteem; however, the majority embrace the basic mission of meeting the medical needs of campers and improving their psychosocial functioning while providing them

with a fun, normalizing summer camp experience.<sup>4</sup> It is generally accepted anecdotally that therapeutic camps meet stated goals or are beneficial to campers' overall well-being.<sup>5</sup> Despite the perception that camps for chronically ill children and adolescents are an effective intervention, scientific investigation regarding the effectiveness and outcomes of these camps is needed.<sup>6</sup> One way of performing such an investigation is by conducting a program evaluation.

A program evaluation examines the overall effectiveness of a program by examining the way services are delivered and measuring how successful the program is in meeting desired outcomes.<sup>7</sup> Program evaluations differ in design depending on the purpose of the evaluation. For example, evaluations designed to determine whether a program meets a specific goal, such as successfully increasing disease-related knowledge, are different from evaluations which aim to determine consumer satisfaction with camp experience.<sup>8</sup> Apart from design, as outlined by Roberts and Steele, several

fundamental components of program evaluation include the collection of demographic information and relevant history such as a child's medical history and prognosis. The inclusion of this information can assist in identification of individual differences among program participants which may influence outcomes. Once a program has been evaluated, the knowledge acquired has the potential to benefit other similar programs, inform consumers of effectiveness and outcomes, elucidate mechanisms of change, and provide important feedback which can be used to modify or expand programs.

Despite the potential utility of conducting program evaluations, there have been a limited number of program evaluations of camps for chronically ill children;<sup>9</sup> of those that have been conducted, few have been able to include child perspectives as well as parents' in the evaluation, satisfaction with the camp experience once campers and their families have returned to their daily lives, or certain chronic illness populations (e.g., children with cancer).

Overall, previous camp evaluations have evaluated pediatric chronic illness camps in order to determine whether camps are meeting their own outlined goals and whether camps more generally help children develop more adaptive or positive attitudes related to illness.<sup>10</sup> For example, Tiemens et al. evaluated a camp for adolescents with a craniofacial difference (CFD) which aimed to provide social support to campers through such means as promoting discussion between campers about shared experiences.<sup>11</sup> Similarly, Hunter et al. examined whether a diabetes camp was meeting its mission statements which included the goals of increasing self-management skills, enhancing emotional adjustment, and enhancing

self-esteem in campers.<sup>12</sup> Additionally, Kiernan and MacLachlan examined an international summer camp for chronically ill children and found that camper preferences for camp components and activities can be strongly influenced by age or gender which suggests that camps can be organized and tailored to meet campers' interests.<sup>13</sup>

The results of existing camp evaluations generally suggest that the camp experience may be beneficial for chronically ill children.<sup>14</sup> For example, Briery and Rabian examined the impact of a summer camp for chronically ill children on children's attitudes toward illness and found that children reported more positive attitudes at the end of camp than at the start.<sup>15</sup> Results of other studies suggest benefits of camp include reduced isolation and increased self-esteem.<sup>16</sup>

When considering the general findings of previous camp evaluations it is important to acknowledge that most published camp evaluations have not been able to assess both parent and camper perspectives of camp experience and have not assessed parent and camper satisfaction with the camp experience upon their return to their daily lives. Furthermore, the majority of existing camp evaluations were not able to assess how camp is helpful to campers or the reasons children enjoy attending camp. Also, there have been a limited number of studies evaluating camps for children with cancer and camps for siblings of chronically ill children. Additionally, many of the existing evaluations in the literature have administered questionnaires on-site and within a month of camp termination. The limited number of published evaluations of camps for children with cancer and their families is of concern given that a majority of the states in the country have at least one pediatric

oncology camp.<sup>17</sup>

## PURPOSE OF STUDY

Due to the potential benefits of program evaluation for campers, families, and organizations, the current program evaluation was conducted with the aim of providing feedback to camp organizers and assessing whether outcomes meet camp goals. Specifically, the current study is a program evaluation of Camp Okizu, a summer camp for pediatric oncology patients and their siblings. The evaluation assessed parent and camper satisfaction with the camp and solicited suggested improvements. Notably, the current study incorporates both camper (oncology patients and their siblings) and parent perspectives, and assesses satisfaction with camp experience, helpfulness of camp, and reasons children like camp at least two months after camp sessions conclude. Additionally, current project aimed to determine if administering mail-based surveys was a sufficient method of assessment.

## METHODS

### PARTICIPANTS

Participants in the current study were children with cancer, siblings of children with cancer, and their parents. Children ranged in age from 5 to 18 (average age of children with cancer = 12.7, SD = 3.06; average age of siblings = 11.6, SD = 2.9). Participants were recruited from Camp Okizu, a camp for pediatric oncology patients and siblings of pediatric oncology patients. Campers are referred to Camp Okizu by medical treatment teams in Northern California medical centers. Children are eligible to attend Camp Okizu if they either currently have, or are survivors of, cancer, as well as children who have a sibling with cancer or had a sibling who died from cancer.

Eighty-nine families participated

in the current study (56 children with cancer, 73 siblings of children with cancer (8 children with deceased oncology patient siblings), and 87 parents (78 mothers, 9 fathers). Fifty-eight male (45.0%) and 71 female (55.0%) campers participated in the study. The majority of participants were White (74.2%) and the remaining participants were Black (5.5%), American Indian (3.1%), Asian (4.7%), or identified as an ethnicity not listed (12.5%). Campers attended one of eight camp sessions, with the greatest number of pediatric oncology patients attending Oncology Week 1 (21.3%) and the greatest number of siblings attending Sibs Week 1 (31.8%). The number of years that campers had attended camp ranged from 1 (23.6%) to 11 (1.6%), with the average number of years being 3.42 (SD = 2.64). The mean age of pediatric oncology patients when diagnosed was 6.9 (SD = 4.2) and the majority of patients underwent chemotherapy treatment (58.4%). The current health status for the majority of oncology patients was off treatment (89.3%), with the remaining participants' current status as on treatment (10.7%).

Forty parents indicated that they were a college graduate (44.9%), 27 parents indicated that they were a high school graduate (30.3%), 17 parents indicated that they had attained a graduate degree (19.1%), 1 parent indicated that they had received some high school education (1.1%), and 1 parent indicated that they had received a 9th grade education or less (1.1%). The median income of participating families was in the range of \$75,000 to \$99,999 (SD = \$50,000).

### MEASURES

Parents completed a *Demographics Questionnaire* which included questions about socioeconomic status, ethnicity, parent education level, and number

of years each child attended camp. Furthermore, parents were asked questions about oncology patient's medical history (e.g., past treatment, current health status, and child's age of diagnosis).

All campers (both siblings and children with cancer) completed a *Camp Evaluation Survey for Campers*. The Camp Evaluation Survey for Campers was created for the current study based on the camp's mission statement and with feedback from camp administration. The measure consists of 26 items and assesses camper satisfaction with camp experience and reasons campers like the camp. Campers were asked to rate camp activities (e.g., cabin group activities, waterfront activities, special events, etc.) and aspects of camp (e.g., the food, counselors, and camp staff) on a five-point Likert scale ranging from "really liked" to "really disliked." Smiley faces (in addition to word ratings) were used to assist children in rating their responses to questions. Additionally, the campers were asked open-ended questions about friendships at camp as well as what could be done to make camp better.

Based on the camp's mission statement, three subscales were created to assess camper satisfaction, in addition to an overall total score for camper satisfaction. The subscales were satisfaction with Recreation, Peer Support, and Camp Features (e.g., staff and food). The Recreation subscale consisted of five items related to events and activities (e.g., waterfront activities, special events, special interest activities, cabin group activities, and night time activities). The Peer Support subscale consisted of three items and assessed camper satisfaction with cabin group activities, bereaved siblings group activities, and a group inspiration activity. The Camp Features subscale consisted of three items and assessed camper

satisfaction with the food, counselors, and staff at Camp Okizu.

Additionally, the Camp Evaluation for Campers assessed reasons why children like attending camp. Based on the camp's mission statement, four subscales were created to assess reasons children like camp. The subscales were Recreation, Respite, Peer Support, and Camp Features. The Recreation subscale consisted of one item and assessed whether campers viewed being outdoors as a reason for liking camp. The Respite subscale consisted of one item and assessed whether campers viewed getting a break from medical treatments as a reason for liking camp. The Peer Support subscale consisted of six items and assessed whether campers viewed making new friends, seeing old friends, being part of a bereaved siblings group, meeting other children with cancer (or other siblings of children with cancer), camp being a safe place where they can trust others, and participating in inspiration activities as reasons why they liked camp. The Camp Features subscale consisted of three items and assessed whether campers viewed the food, counselors, or other staff at camp as reasons for liking camp. Additionally, an overall total score was created which assessed campers' satisfaction with camp as well as reasons for liking camp.

All parents completed a *Camp Evaluation Survey for Parents*. Similar to the Camp Evaluation Survey for Campers, the Camp Evaluation Survey for Parents was based on the camp mission statement and feedback from camp administration. The measure consists of 20 items and assesses parent satisfaction with child(ren)'s camp experiences and helpfulness of camp. Parents were asked to rate their satisfaction with different components of camp, as well as what was helpful about camp.

In the Camp Evaluation Survey for Parents, parents rated their satisfaction with Camp Okizu in a range of areas. Based on the camp's mission statement, three subscales were created to assess parent satisfaction, in addition to an overall total score for parent satisfaction. The subscales were satisfaction with Recreation, Respite, and Camp Experience. The Recreation subscale consisted of one item and assessed parents' satisfaction with camp activities available to their child(ren). The Respite subscale consisted of three items and assessed parents' satisfaction with medical care at camp, responsiveness of camp administration, and transportation offered by camp. The Camp Features subscale consisted of three items and assessed parents' satisfaction with the food at camp, the counselors, and camp facilities.

Similarly, parents were asked questions about how helpful different aspects of camp were to their child(ren) on a five-point Likert scale ranging from "not at all" to "very much." The survey asked about parent's satisfaction with the child's camp experience with activities, food, counselors, and facilities. Parents were also asked about how helpful the camp experience was for their child(ren) in a number of domains (e.g., child's level of independence).

Based on the camp's mission statement, three subscales were created to assess reasons parents view camp as helpful. The subscales were Respite, Peer Support, and Child Improvements. The Respite subscale consisted of three items and assessed whether parents viewed knowing their child(ren) had adequate medical care, taking a break from caretaking responsibilities, and knowing their child(ren) is/are safe at camp as reasons camp is helpful. The Peer Support subscale consisted of one item and assessed if parents

viewed child(ren) being with others who understand their situation as a reason camp is helpful to their child(ren). The Child Improvements subscale consisted of three items and assessed whether parents noticed improvements after camp in their child's feelings about themselves, behavior, or level of independence and if these improvements were a reason they considered camp to be helpful. Moreover, parents were asked open-ended questions about suggested improvements, how camp is helpful to their child(ren), and general comments/feedback. Additionally, an overall total score was created which assessed both parents' satisfaction with camp as well as reasons camp is helpful.

#### *PROCEDURE*

All families who registered for camp in the summer of 2008 were mailed a cover letter describing the study, consent form, and stamped return envelope. Parents were asked to sign the consent form and return it to study investigators. Investigators resent consent materials to families who did not respond to this first mailing. Recruitment occurred in two waves; the first wave of recruitment targeted the families of all children registered for camp during summer 2008. A second wave of recruitment mailings was also conducted to ensure that all families were given an opportunity to participate. As a result of the first mailing, 78 families (87.7%) returned signed consents and 11 families (12.3%) returned consents as a result of the second mailing. Of those who returned consents (89 families, 100%) completed the study questionnaires.

Families who consented to participate in the study were mailed questionnaires after camp sessions had concluded, during the months of October and November. Parents were also provided with an assent

statement to read to children and a postage-paid return envelope for the questionnaires. All procedures for the current study were approved by the university's institutional review board.

## RESULTS

### *CAMPER EVALUATION*

Scores (mean items) on the Camp Evaluation for Campers ranged from 1 to 5, with 1 being "really liked" and 5 being "really disliked." The mean satisfaction rating across all items was 1.5 (SD = 0.4) which indicates that campers generally "really liked" to "liked" camp. On average, camper ratings on the Recreation subscale items were 1.4 (SD = 0.4), and on the Camp Features subscale items were which averaged 1.4 (SD = 0.4), indicating that campers generally "liked" to "really liked" recreational aspects of camp as well as basics of the camp experience. Of the subscales, the Peer Support had the highest average of all subscales, with an average of 1.7 (SD = 0.7) which indicates that campers generally "liked" to "really liked" the peer support aspects of camp.

On average, camper ratings for the reasons that campers liked camp was assessed on the Recreation subscale items, which were 1.5 (SD = 0.7), on the Peer Support subscale items, which were 1.5 (SD = 0.6), and on the Camp Features subscale items, which were 1.4 (SD = 0.5), indicating that campers generally viewed recreation at camp, peer support at camp, and features of the camp experience as reasons they "liked" to "really liked" camp. Of the subscales, Respite had the highest average, with an average of 1.7 (SD = 0.8) which indicates that campers generally view respite as a reason they "liked" to "really liked" camp.

An overall total score which assessed campers' satisfaction with

camp as well as reasons for liking camp averaged 1.5 (SD = 0.4) which indicates that campers generally "liked" to "really liked" camp and could identify reasons that they liked camp.

### *PARENT EVALUATION*

Scores (mean items) on the Camp Evaluation for Parents ranged from 1 to 4, with 1 being "very dissatisfied" and 4 being "very satisfied." The mean satisfaction rating across all items was 3.5 (SD = 0.9) which indicates that parents were generally "satisfied" to "very satisfied." Of the subscales, Recreation had the highest average satisfaction level, with an average of 3.6 (SD = 1.0) which indicates that parents were generally "satisfied" to "very satisfied." On average, parent ratings on the Respite subscale items were 3.5 (SD = 0.9) and on the Camp Features subscale items were 3.5 (SD = 0.9), indicating that parents were generally "satisfied" to "very satisfied" with respite as well as features of the camp.

Scores (mean items) on the section of the evaluation assessing reasons parents view camp as helpful ranged from 1 to 5, with 1 being "not at all" and 4 being "very helpful." Of the subscales, Peer Support had the highest average rating (M = 4.0, SD = 0.3) which indicates that parents considered peer support as "very much" a reason why camp is helpful to their child(ren). On average, parent ratings on the Respite subscale items were 3.7 (SD = 0.5), and on the Child Improvements subscale items were 3.6 (SD = 0.5), indicating that parents viewed child improvements after camp and respite as "somewhat" to "very much" reasons why camp is helpful.

An overall total score which assessed parents' satisfaction with camp as well as reasons camp is helpful averaged 4.14 (SD = 0.71) which indicates that overall parents

were generally satisfied with the camp and found that many features of camp were helpful to their children.

#### *QUALITATIVE DATA*

At the conclusion of the Camp Evaluation for both Parents and Campers were open-ended questions designed to solicit feedback and suggestions for camp improvement. When asked what were reasons for returning to camp each year a large number of campers stated that getting away from home, the supportive and understanding atmosphere of camp, and the feeling of belonging between campers were reasons they kept coming back. Campers frequently reported that they learned new skills at camp ranging from making friendship bracelets and kayaking to acquiring leadership skills and being open to others. Parents reported that the main reasons camp was helpful to their children include the level of peer support and understanding among campers, the confidence and independence boost, and the escape from stressful daily life.

#### **DISCUSSION**

Overall, parent and child satisfaction with camp ratings were between “satisfied” and “very satisfied” suggesting that camp is viewed as positive and helpful by the majority of campers and their families. Child satisfaction ratings, as well as reasons for liking camp, indicated that children were most satisfied with aspects of the overall camp experience (which included food, staff, counselors, and facilities). Out of the four subscales assessed on the evaluation, campers consistently rated camp experience highest on satisfaction and as a reason for liking camp which suggests that campers enjoy and are happy with the environment of summer camp. Parent satisfaction responses indicated that parents were most satisfied

with aspects of camp related to child and parent relief from daily stress, whereas in terms of the reasons parents think camp is helpful, parents rated peer support the highest. One aspect of camp that is related to peer support in the activity of Inspiration. This is a time when the entire camp comes together to acknowledge that everyone there has had cancer affect them or their family. It is a time when campers can talk openly about their experiences or simply listen to others.

In addition, child responses on the satisfaction survey indicated that children were least satisfied with peer support; however ratings on the Peer Support subscale were still fairly high. As for reasons children liked camp, aspects of camp related to the Respite subscale were rated low, indicating that children generally “neither liked nor disliked” to “disliked” relief from daily life while at camp.

An additional suggestion of the current study is that it appears that the process of assessing parent and camper satisfaction through mail-based surveys is a feasible method for obtaining feedback relevant to chronic illness summer camps and specifically, conducting program evaluations.

There is some disagreement in the findings between what parents view as helpful about camp and what children actually like about attending camp. For example, parents view peer support as the highest rated of all the reasons camp is helpful to campers. This perception by parents is not held by children either in terms of camper satisfaction with different aspects of camp, in which campers rate peer support lower than overall camp experience, or in terms of reasons for liking camp, in which children rate peer support as being equal to recreation and least favorable of the camper satisfaction subscales.

There are several possible explanations for the discrepancy

between parent and child perspectives on camp. First, parents might view campers meeting other campers who can empathize and understand what they have been through as the most beneficial feature of camp; however, campers rate camp experience the highest suggesting that they view camp as valuable simply by being able to go and have a fun week away from their daily lives. Second, perhaps differences in the evaluation scales are responsible for the disagreement between parent and child(ren) report. That is, parents evaluated camp on how satisfied they were and reasons camp was helpful, whereas children evaluated camp on how satisfied they were and reasons they liked camp. Thus, the difference between parent and child responses might be due to the fact that what children like about camp and what about camp is helpful are two separate constructs.

The current study's findings differ somewhat from those of previous studies. In a camp evaluation by Hunter et al., results indicated that camp goals to increase camper self-management skills and self esteem were not fully supported.<sup>18</sup> However, in the current study, results suggest that camp is successful in meeting its goals based on high camper and parent satisfaction on the subscales of Recreation, Respite, and Peer Support. In another study, Tiemens et al. concluded that the use of social group work or peer support and peer understanding are promising components to be incorporated into future interventions for adolescents with a CFD.<sup>19</sup> This contrasts with the current study because peer support was not rated highest by campers as a reason for liking camp or as an aspect of camp with which they were satisfied. (However, it is interesting that open-ended responses from campers and parents included peer support as an important feature of

camp.) Perhaps children affected by cancer and their families are more interested in having fun and getting a break from daily life than in meeting peers who understand what they have been through.

Additionally, it is possible that the methodology of the current study contributed to findings that are dissimilar from those in the existing literature. For example, the current project is one of the first studies to include both parent and camper perspectives. Perhaps the method of incorporating both parent and camper evaluations enables a more accurate sense of camp satisfaction by examining differences or similarities between the two reports and attempting to determine reasons for their existence. Multisource data assists in reducing the possibility of biased responses as well as enabling investigators to negate alternative explanations for results.<sup>20</sup>

The results of the current study should be interpreted with several limitations in mind. The current study is limited by the absence of two subscales on the evaluation forms. Specifically, the subscale of Peer Support was not assessed on the satisfaction component of the Camp Evaluation for Parents and the subscale of Respite is not assessed on the reasons why campers like camp component of the Camp Evaluation for Campers. Parent satisfaction was not assessed on the Peer Support aspects of camp because we expected campers to be the best reporters of their own perceived level of peer support; however, future research might incorporate parent perceptions of satisfaction with child peer support at camp. The current study operationalized Respite differently for parents and campers. Respite for parents incorporated features of camp which allowed parents a break from care-taking responsibilities

whereas respite for campers was operationalized as receiving a break from medical treatment. In order to streamline the questionnaire, Respite was not assessed for reasons campers liked camp because the majority of campers were off-treatment. Future research should aim to replicate the current evaluation with other camps of similar illness or with camps with a different structure. Future studies will also need to replicate the current results in more economically and ethnically diverse samples. Additionally, determining possible reasons that this camp does not serve more economically and ethnically diverse samples would be important in order to maximize camp outreach and overall effectiveness. For example, do children from all socio-economic backgrounds have the option to attend camp or do those from lower socio-economic families not get referred as often.

The current program evaluation has the potential to help improve the services of Camp Okizu by assisting camp administration in efforts to more effectively meet camp goals. The feedback received from both parents and campers offer suggestions to enhance components of camp in order to make activities available more diverse or more fitted to the interests of the consumers. For example, campers proposed numerous ideas for new special interest activities to be offered at camp (e.g., cooking/fun with foods, boating/fishing, dance/yoga, and art/drama). This particular suggestion might serve to better meet

the camp's aim to provide recreational opportunities to campers by offering a variety of activities in which previous campers have expressed interest. Parents and campers also reported suggestions to improve camp design in other ways.

Campers most commonly suggested more special interest time, longer sessions, access to ropes course for all ages, and availability of more teenage activities. Parents' suggestions had several areas of overlap with campers'; parents proposed creating longer sessions, offering a winter session, making better tasting and healthier food available, and helping families stay in contact (e.g., providing a camper contact information sheet to parents so that young children are able to keep in touch with other campers with the help of parents or posting pictures of campers on camp website so that parents can keep updated on what is going on). It is possible that these improvements will not only increase parent and camper satisfaction with the camp experience but the alterations may also serve to further Camp Okizu in fulfilling their mission statement.

Future evaluations should aim to systematically evaluate camps in order to improve outcomes by including camper and parent reports in the evaluation and by careful examination of aspects of camp that both campers and parents view as beneficial so that camps can build upon existing components which families identify as beneficial as well as so that camps can continue to improve their services.

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# The Role of Cockroach Allergens in the Racial Disparity in Childhood Asthma Rates

## INTRODUCTION

Asthma is a common respiratory disease that affects more than 22 million Americans, 7 million of whom are children.<sup>1</sup> Symptoms include wheezing, coughing, chest tightness, and shortness of breath. A severe episode, known as an “asthma attack,” can lead to loss of consciousness or death if inappropriately treated. However, with proper care the disease is manageable for most sufferers.

There is a conspicuous racial disparity in asthma rates in the United States, as the disease is 39% more prevalent among African Americans than European Americans.<sup>2</sup> Children living in predominately African American inner cities suffer asthma at greater rates than the general population and experience greater morbidity.<sup>3</sup> This has lead many observers to call childhood asthma in urban environments an “epidemic.”<sup>4</sup>

Research has shown that cockroach allergens are a primary agent in exacerbating childhood asthma. African American children are 15.8 times more likely to be exposed to these allergens in their bedrooms

than European Americans.<sup>5</sup> The policy implications of this problem deserve attention.

In this paper, I examine the research on cockroach allergens and their role in childhood asthma, with attention paid to the relevant issues of race and socioeconomic status. I conclude with policy recommendations for combating the racial disparities in childhood asthma.

## ASTHMA ETIOLOGY

The exact cause of asthma is unknown, but there is strong evidence that environmental factors can help trigger the disease in those who are genetically susceptible.<sup>6</sup> These factors include outdoor air pollutants; tobacco smoke; cooking emissions; mold; allergens from pets, rodents, dust mites, and cockroaches; as well as psychological stress resulting from early exposure to violence and a lack of community cohesion.<sup>7</sup> Even if these factors do not actually cause asthma, they are known with certainty to increase its morbidity.

Cockroach allergens are derived from the insect’s fecal material, saliva,

dead body parts, and more, and have been shown to be particularly pernicious to asthma sufferers—more so than dust mite or pet allergens.<sup>8</sup> Moreover, high quantities of cockroach allergens are one of the best predictors of asthma morbidity in children.<sup>9</sup>

### **SPATIAL DISTRIBUTION**

Cohn et al.<sup>10</sup> analyzed data from the National Survey of Lead and Allergens in Housing and found that approximately 63% of U.S. homes contain detectable levels of cockroach allergens. Living room floors were the most frequent site of detectable levels, but kitchens contained the highest levels overall. Northeastern and Midwestern homes exhibited higher living room concentrations than homes in the South or West, which tended to have higher concentrations in the kitchen.<sup>11</sup> Midwestern homes had the highest average cockroach allergen levels of any region,<sup>12</sup> but the cities of New York, the Bronx, and Dallas were also especially afflicted.<sup>13</sup> Multiple studies have shown that inner city homes exhibit higher cockroach allergen levels than suburban homes.<sup>14,15,16</sup>

### **STRUCTURAL DISTRIBUTION**

The likelihood that a given dwelling contains cockroach allergens is correlated with its structure. Cohn et al. examined this relationship and found that high-rise apartments exhibited much higher cockroach allergen concentrations than any other form of housing.<sup>17</sup> Eighty-four percent of high-rises had detectible levels, a rate more than twice as high as low-rise apartments, row houses, and mobile homes. Moreover, 37% of high-rises had concentrations above 8 U/g (units of allergen per gram of dust), the minimum level at which full sensitization is likely to occur; only 0.8% of detached single homes contained similar levels. Urban

housing in general was more likely to possess elevated allergen levels, as were constructions built before 1940.<sup>18,19</sup>

### **DEMOGRAPHIC DISTRIBUTION**

Sarpong et al. found that bedroom cockroach allergen exposure was 4.4 times more probable for urban children than for suburban children.<sup>20</sup> After controlling for location, the data showed that African American children were 15.8 times more likely to be exposed to the allergens than European American children. After adjusting for socioeconomic status (SES), middle-class African American children were still 11 times more likely to be exposed to the allergens than middle-class European American children.

Sensitization and skin test reactivity rates followed these trends closely. In the same study, Sarpong et al. found that urban children were four times more likely to exhibit positive skin test reactivity to cockroach allergens than suburban children.<sup>21</sup> African American children were 16.4 times more likely to develop a sensitivity to the allergens than European American children. When adjusted for both race and SES, the data showed that 75% of asthmatic African American children of low SES were sensitized to the allergens.

### **DISCUSSION**

African American children suffer from asthma morbidity more than any other group in the United States,<sup>22</sup> and their high exposure to cockroach allergens is a significant component of this problem. Much, or even most, of the reason for this is that African American children are more likely to be poor, live in substandard housing, and reside in the inner city than European American children. However, the most puzzling aspect of the situation is that some studies

found evidence of racial disparity even after controlling for SES. The question remains as to why middle-class African American children, for instance, would be exposed and sensitized to cockroach allergen more than middle-class European American children. (It should be noted, however, that some studies did not find race to be a factor that was independent of SES.)

Genetic differences between the two races may have an effect, but the evidence points more to social and environmental factors. As Wright and Subramanian have noted, race is not a true biological characteristic in a strict scientific sense; rather, it is a more of a social construct.<sup>23</sup> This leaves the field open to other possible explanations that have not been as thoroughly researched. For example, obesity is suspected to contribute to the development of asthma, leading some to speculate that the higher prevalence of obesity among African Americans could help account for the disparity in childhood asthma rates.<sup>24</sup> Other researchers draw attention to the fact that African Americans smoke more than European Americans;

environmental tobacco smoke produced by parents could perhaps interact with pollutants and allergens to create a synergistic effect on childhood asthma morbidity.<sup>25,26</sup>

## CONCLUSION

It is clear that disentangling the role of race in childhood asthma will require more research. In the meantime, however, governments can take two simple steps to mitigate the problem of cockroach allergen exposure.

First, public health authorities should allocate more resources to pest control in inner cities and high-rise apartments, for professional extermination services have been shown to drastically reduce cockroach populations.<sup>27</sup> Second, governments should engage public service advertising campaigns or other media to educate citizens of lower SES on pest prevention and proper household cleaning techniques. McConnell et al. demonstrated the value of this when they reported a 64% reduction in cockroach allergen in homes targeted for educational intervention when compared to a control group.<sup>28</sup>

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