



# Indiana University Journal of Undergraduate Research

Volume III, 2017

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# LETTER FROM THE EDITORS

Dear Reader,

We proudly present Volume III of the Indiana University Journal of Undergraduate Research (IUJUR). We are so grateful for the continued support of administrators, faculty, staff, students, and the university who are committed to the mission of engaging with and cultivating the vibrant spirit of the Indiana University community.

As a student-run, faculty-mentored publication, IUJUR aspires to promote the enthusiasm, passion, and curiosity of dedicated students and faculty mentors conducting undergraduate research across a broad spectrum of disciplines. The progress that has been made in pursuing this mission would not have been possible without the admirable efforts and dedication of the IUJUR staff, expertise of the Faculty Advisory Board, and guidance of our terrific faculty advisors.

Ranging from works such as an inventive analysis regarding Walt Whitman's references to stars and astronomy throughout his revisions of *Leaves of Grass* to a proposal expounding on our current understanding of gravity to integrate quantum mechanics and the theory of relativity, we are delighted to present excellent submissions that highlight the broad diversity of academic and creative exploration conducted across Indiana University. Not only do these submissions serve to showcase the remarkable intellectual capacity and passion of our student body and faculty, but they also represent the merits of student-faculty research collaboration. We would like to especially recognize the faculty mentors for advising, supporting, and challenging their students to push their boundaries and soar to new heights. The invaluable support of faculty mentors, along with the time and effort of our Faculty

Advisory Board, is key in ensuring the quality of the undergraduate research featured in this journal.

As our initiative endeavors to bridge together diverse areas of study and encourage the dynamic culture of curiosity at Indiana University, we are optimistic about the role of the Journal in providing a forum for the growing undergraduate research community. We hope to continue to grow and learn together as an academic publication and student organization. Thank you for your support and we hope you enjoy reading this issue.

Sincerely,

Rayne Kim & Sonali Mali  
Editors-in-Chief

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# *natural sciences*

- 04 A Proposed Experiment to Test Spin-Dependent Effects Beyond Einstein's Theory of Gravitation: The Pound-Rebka Experiment with Spin

A spinning top toy is shown in motion, blurred to indicate speed. It has a dark, cylindrical body and a flat, circular top. The background is a vibrant, out-of-focus pattern of orange, red, and blue. The text "Natural Sciences" is overlaid in the bottom right corner.

# Natural Sciences

# A Proposed Experiment to Test Spin-Dependent Effects Beyond Einstein's Theory of Gravitation: The Pound-Rebka Experiment with Spin

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## ABSTRACT

Einstein's geometric theory of gravity was constructed in part to explain why test particles in a gravitational field all follow the same trajectory independent of the mass of the particle. However, it is known that point particles in quantum mechanics must all possess at least two properties: mass and angular momentum. Many have speculated that spin-dependent effects in gravity might exist which are not contained in Einstein's theory, yet few experimental tests for such a possibility have ever been conducted. We describe an experiment which is very similar to the famous Pound-Rebka experiment, which used the Mössbauer effect to verify for the first time Einstein's prediction for the curvature of time, but which employs Mossbauer emitters and absorbers with nonzero spin. We present a specific, realistic proposal for such an experiment. We outline the theory for the "normal" effects of general relativity a la Pound-Rebka, the proposed experimental apparatus including spin-polarized emitters and absorbers, the expected sensitivity of the experiment, and potential sources of systematic error.

**KEYWORDS:** gravity, Mössbauer, quantum mechanics, angular momentum

## RATIONALE

The apparent conflict between our understanding of gravity and quantum mechanics is one of the major unsolved problems of physics. It is perhaps not surprising that this question remains unresolved. Gravity is by far the weakest of the interactions that we presently identify as fundamental, and so far all of the available experimental data on its properties emerge from conditions in which we expect Einstein's description of gravity, in terms of a classical curved space-time with no excitation of possible quantum modes, to be valid. Our best guess for the distance scale at which one might expect effects from quantum gravity to appear, about  $10^{-33}$  m as identified by Planck more than a century ago, is about 15 orders of magnitude smaller than any distance scale that has yet been directly probed in the laboratory and about eight orders of magnitude smaller than the distance scale accessible in even the highest energy cosmic rays to have been detected on Earth so far. Even the value of the gravitational constant  $G$  remains controversial: in a recent evaluation of  $G$  by the CODATA group on fundamental constants, the group assigned an uncertainty to  $G$  (based on the observed spread of "precision" experiments) which is only two orders of magnitude better than that measured by Cavendish two centuries ago. The irony is rich: from Newton's quantitative analysis of gravity that led to the scientific revolution and the fact that gravity is so weak, one might expect that the weakest fundamental force first isolated in physics would also be the best understood. Nothing can be further from the truth.

A natural consequence of this severe disconnect between theory and experiment in quantum gravity is the proliferation of speculative theories which give new effects that are large at the Planck scale but very small by the time the effects are extrapolated to the lower energies where we can presently do laboratory experiments. This circumstance has naturally lead theorists to analyze thought experiments on black holes in an attempt to identify, by pure thought, new fundamental principles to guide the construction of a quantum gravity theory. Much theoretical effort has also gone into the applications of quantum gravity ideas to the very early universe with the hope that some residue of these effects might survive the Big Bang and leave an imprint on observables like the cosmic microwave background. Still other approaches try to get rid of the problem by asserting that gravity is not a "real" fundamental force at all and is instead some small residual effect from one or more of the other interactions. Unfortunately, with few exceptions, these approaches have so far led to few consequences which are testable either by astronomical observation or by laboratory experiments. The recent realization that the mass energy of the universe is dominated by dark matter and dark energy comes from analysis of the dynamics of the universe at times when gravitational effects are dominant. Naturally, one might speculate that intellectual progress in our understanding of quantum gravity might have some bearing on the solution to this other major problem of physics. This revolutionary observation of dark energy has greatly expanded the number

of scientists who really want to understand gravity: It is now not just the academic interest of a small group of theorists but also a more and more pressing issue for other researchers.

Based on our knowledge of quantum mechanics, what physics variable might be the most likely to exhibit quantum gravity effects? One popular candidate is spin. We know spin to be the most quantum mechanical of the physics properties: Turn off Planck's constant and it vanishes. We also know from Wigner's analysis of the representations of the Poincare group that an isolated particle in flat space-time need only possess two necessary properties: mass and spin. Naturally, this idea that somehow spin should be incorporated into gravity is a very old one, dating to Cartan's ideas of spacetime torsion and continuing to the present day. Therefore, it is perhaps somewhat surprising that few gravitational experiments have been conducted which involve the measurement of spin observables.

It seems appropriate at this time to conduct more experiments involving spin and gravity for a number of reasons. First of all, the technology for producing macroscopic ensembles of polarized electrons and nuclei has greatly advanced over the last couple of decades. The number density of polarized species, the size of the polarization of the ensembles, and the delicacy with which the spins can be manipulated and measured have all greatly improved. In addition, the traditionally pessimistic theoretical estimates for the sizes of spin effects in gravity seem more and more obsolete. As an example, we consider within this context the theoretical work on the violation of CPT and Lorentz symmetry within the Standard Model Extension. This approach, which by contrast to almost all quantum gravity work takes a phenomenological approach to the problem by proposing what is basically an effective field theory for quantum gravity in the low energy limit, has identified a host of new sources for possible physical effects which have never been sought for experimentally. If there is one thing that one might guess is violated at the Planck scale, it is the CPT theorem of local quantum field theory, which is still one of the most poorly understood of the fundamental symmetries of spacetime. It is known that, under very general conditions, allowing for CPT violation forces one to also introduce the violation of Lorentz symmetry. Recently, this SME approach has been extended to gravity. While the theory is still under construction, one thing is already clear: it is quite possible that CPT/Lorentz violating gravitational effects involving the spin of particles can be quite large, contrary to previous estimates.

In this paper, we describe and analyze an experiment which could be performed to test theories which leads to spin-dependent effects in gravity. This experiment is the spin-dependent version of a famous experiment in physics: the Pound-Rebka experiment, which was used in the 1950s to measure the redshift of photons in the gravitational field of the Earth. Our proposed twist on this well-known experiment is to conduct it using polarized photons and to search for a possible photon helicity dependence to the

gravitational redshift. The prediction of general relativity is that there is absolutely no such dependence. We first describe some of the key ideas behind the physics of the gravitational redshift as probed in the original experiment, which was not sensitive to the photon polarization. We then describe the modifications that would need to be made to conduct a very similar experiment with polarized photons and discuss its potential sensitivity and some of the potential sources of systematic errors that might be present. Unfortunately we are not yet able to compare this projected sensitivity with any specific theoretical predictions, which to our knowledge do not yet exist.

## 1. REVIEW OF THE MÖSSBAUER EFFECT

We first review some of the key physics ideas which one must first understand to appreciate the original Pound-Rebka experiment.

Consider an unstable nucleus with mass  $m_1$  and energy  $E_1$  which emits a photon. The photon is released with an energy  $E_{ph}$ , which is also equal to its momentum since the photon is massless. Let the energy and mass of the nucleus after the photon is emitted be  $E_2$  and  $m_2$  respectively. Although it is common to say that the energy of the photon is  $E_{ph} = E_1 - E_2$ , this is not entirely accurate. When the nucleus emits a photon, it actually recoils slightly in the opposite direction that the photon was emitted. Thus we must approach the problem relativistically, such that the law of conservation of four-momentum is not broken.

Using the known equations for relativistic energy and momentum, we can derive the correct equation for the momentum  $p$  due to the recoil of the nucleus and subsequently the energy  $E_{ph}$  of the photon:

$$cp = E_{ph} = \left( \frac{m_1^2 - m_2^2}{2m_1} \right) c^2 \quad (1)$$

Now consider briefly the implication of this result for the probability of absorption of this photon by a second nucleus. Since the energy of the emitted photon is smaller than  $E_1 - E_2$ , this photon would not be absorbed by the second nucleus due to insufficient energy. So if the two nuclei in question are in isolated space, the second one cannot absorb the photon produced by the first one.

The Mössbauer effect refers to a modified situation in which the second nucleus can absorb the photon. This effect can occur if the nuclei in question are bound in some solid material (early work used the nucleus  $^{57}\text{Fe}$  embedded in a solid matrix). If the atom that the nucleus is inside of is itself bound inside a solid material, then there is some nonzero probability that the recoil momentum that emits the photon is recoilless, i.e. it has no momentum in the opposite direction of the photon after emission. Technically speaking, the word "recoilless" cannot be correct as that would imply a violation of conservation of momentum. What is meant is that the

recoil momentum is taken up collectively by all of the atoms in the material as a whole, so that the mass of the recoiling object is not the mass of the atom but rather the mass of the entire object. In the limit that the object itself has effectively infinite mass, this recoil velocity tends to zero. In practice, for a macroscopic body this recoil momentum can be so small that it is smaller than other physical effects, which leads to a slight spread in the distribution of the possible energies of the emitted photon. In this case the central value of the spread of photon energies can be centered at  $E_1 - E_2$ . Therefore the second nucleus can absorb some of these photons. This is the Mössbauer effect.

### 1.1 Gravitational Redshift

We now briefly discuss the phenomenon that the Pound-Rebka experiment applied the Mössbauer effect to measure, namely the gravitational redshift. The gravitational redshift consists of a shift in the energy a particle which moves between two points in a curved spacetime. The Pound-Rebka experiment measured for the first time the shift in photon energy between two points at different heights in the gravitational field of the Earth. The expression for the fractional shift in the photon energy between two different heights  $h$  near the surface of the Earth is

$$\frac{\delta E}{E} = \frac{gh}{c^2} \quad (2)$$

which for a height difference of order 10 meters is of order  $10^{-15}$ . In the case of the 14.4 KeV photon energy from the transition of interest in  $^{57}\text{Fe}$ , the gravitational redshift is of order  $10^{-11}$  eV.

This shift is fantastically small. Nevertheless, it can be measured with care. We now describe some of the physical effects which must be considered to conduct such a measurement. One important effect is the spread of photon energies which comes from the finite lifetime of the excited state which produces the photon. This spread of energies possesses a width which comes from the time-energy uncertainty relation in quantum mechanics,

$$\Delta E \Delta t \sim \hbar \quad (3)$$

where  $\Delta E$  is the uncertainty in energy associated with the state and  $\Delta t$  is the uncertainty in time associated with the state. Using  $\hbar = 6.58 \times 10^{-16} \text{ eV} \cdot \text{s}$  and the lifetime of the first excited state of  $\Delta t = 97.8 \text{ ns}$  [10], one gets  $\Delta E = 7 \times 10^{-9} \text{ eV}$ .

This is almost a factor of 1000 larger than the size of the physical effect being sought, which means that one has to be able to resolve the shift in the mean value of the photon energy to better than a part in 1000 to have a hope to see the physical effect. For practical reasons, the only way to do this in the presence of the usual sources of noise in any real experimental apparatus is to oscillate the signal of interest with a known frequency and search for the signal only at that frequency. This principle is known as lock-in detection. It greatly attenuates all sources of noise which do not possess frequency components at or near the frequency of oscillation

of the effect of interest. In our case it means that we need to oscillate either the source of the absorber or the Mössbauer photons. However, the motion of the source introduces another contribution to the photon energy that must be taken into account.

This shift from the relative motion of the source and absorber can be thought of as a Doppler effect. The Doppler shift in general describes the change in frequency observed when a source is moving relative to an observer. The waves are raised in frequency if the emitter moves toward the observer, and lowered in frequency if the emitter moves away. This effect holds for light even when the emitter moves at relativistic speeds.

Consider an observer stationary in its own Frame. An emitter moves past it at a speed  $\beta$  and emits a pulse of light at the start of every interval  $\Delta\tau$ , as measured at the emitter (staying stationary in the other Frame moving at speed  $\beta$ ). For these light flashes, proper time ( $\Delta\tau$ ) is measured at the emitter; therefore, the time between emissions of light as seen by the observer ( $\Delta t_E$ ) is affected by relativistic time dilation and thus is given by:

$$\Delta t_E = \frac{\Delta\tau}{\sqrt{1-\beta^2}} \quad (4)$$

This is the time between emissions of the light flashes; however, this is not the time between receptions of consecutive light flashes. The emitter moves a distance of  $\beta\Delta t_E$  between flashes in the home Frame, and so the light from the second flash will have to travel an altered distance (shorter for approaching velocities and longer for receding velocities) to reach the observer. Therefore, the time between receptions of flashes  $\Delta t_R$  is given by:

$$\Delta t_R = \Delta t_E + \beta\Delta t_E = \Delta t_E(1 + \beta) \quad (5)$$

After substitution of Eqn.(4) into Eqn.(5), this becomes:

$$\Delta t_R = \frac{\Delta\tau(1 + \beta)}{\sqrt{1 - \beta^2}} = \Delta\tau \sqrt{\frac{1 + \beta}{1 - \beta}} \quad (6)$$

This phenomenon means that the fractional shift in the photon energy becomes

$$\frac{\delta E}{E} = \sqrt{\frac{1 - \frac{v}{c}}{1 + \frac{v}{c}}} \cdot \frac{1 - \frac{2GM}{(R+h)c^2}}{1 - \frac{2GM}{Rc^2}} \quad (7)$$

where  $M$  is the mass of the Earth,  $R$  is the radius of the Earth,  $h$  is the height above the Earth's surface,  $G$  is Newton's gravitational constant,  $c$  is the speed of light, and  $v$  is the relative velocity between the source and the absorber. For the case of the 14.4 KeV transition in  $^{57}\text{Fe}$  we are using as an example, the speed needed so that the Doppler shift equals the size of the gravitational redshift is of order

$$v \approx \frac{gh}{c} = 10^{-3} \text{cm} \cdot \text{s}^{-1} \quad (8)$$

which is a slow enough velocity to be varied with high precision in a practical apparatus. The idea for the measurement is then realized as follows. The source and absorber are placed at different heights in the gravitational field of the Earth. The emitter is oscillated at a constant frequency  $\omega$  and with an amplitude which ensures that the Doppler effect and the gravitational redshift cancel for some point in the phase of the oscillation. At that point, the photons have the correct energy to be resonant with the absorber, and one detects the subsequent fluorescence signal from the de-excitation of the absorbed Mössbauer photons. Then the roles of the emitter and absorber are switched to isolate the gravitational redshift effect from the Doppler effect.

## 2. PHYSICS ISSUES RELEVANT TO THE EXPERIMENT

We first review some of the key physics ideas which one must first understand to appreciate the original Pound-Rebka experiment.

### 2.1 Efficiency for the Mössbauer effect

#### 2.1.1 Probability of recoilless emission

The relative odds that recoilless emission of the photon occurs depend on certain properties of the nucleus and the material. The Mössbauer effect is most likely to occur if:

1. **The  $\gamma$ -ray energy is small, and consequently  $E_R$  is small as well.**

$^{57}\text{Fe}$  has  $E_\gamma = 14.41$  keV, which is modest compared to the energy of most nuclear  $\gamma$ -decays in light nuclei.

2. **The temperature of the source medium is low.**

Phonons in the medium can interact with the atom and cause the gamma emission energy to change such that it is not in resonance with the absorber.

3. **The Debye temperature of the crystal lattice is high.**

In thermodynamics and solid state physics, the Debye temperature  $T_D$  is the equivalent temperature of the crystal's highest normal mode of vibration. A higher Debye temperature means that the density of normal modes which can perturb the atoms is lower. For the  $^{57}\text{Fe}$  source,  $T_D \approx 470$  K. [8]

The fraction of  $\gamma$ -ray emissions which will be recoilless ( $f$ ) can be estimated using the Debye model, which assumes a continuum of oscillator frequencies to model the solid crystal lattice up to a maximum set by  $\omega_D = k_B T_D$ .  $f$  can be expressed as:

$$f \approx \exp \left( -\frac{E_R}{k_B T_D} \left\{ \frac{3}{2} + \frac{\pi^2 T^2}{T_D^2} \right\} \right) \quad \text{for } T \ll T_D \quad (9)$$

or,

$$f \approx \exp \left( -\frac{6E_R T}{k_B T_D^2} \right) \quad \text{for } T > \frac{T_D}{2} \quad (10)$$

This fraction depends on the nucleus used for the experiment. In the case of  $^{57}\text{Fe}$ , the probability of emitting a  $\gamma$ -ray without nuclear recoil at 0 K, 80 K and 300 K is approximately 0.93, 0.92, and 0.83 respectively. The  $^{57}\text{Fe}$  values for  $f(T)$  up to 400 K are plotted in Fig.(1). It is evident that, even at room temperature, a large proportion of the  $\gamma$ -emissions from the  $^{57}\text{Fe}$  source will be effectively recoilless, and that cooling the source would not generate more than a  $\sim 10\%$  improvement in efficiency.

#### 2.1.2 Probability distribution for recoilless absorption

The random emission process then leaves the probability to be distributed in Gaussian form.

$$P_{\text{absorption}} \propto \exp\left(\frac{-\chi^2}{2\sigma^2}\right) \quad (11)$$

$$P_{\text{absorption}}(E, E_\gamma, \delta E, v, h) = \frac{1}{\sqrt{2\pi\delta E^2}} \cdot \exp\left(-\frac{(E - E_\gamma(v, h))^2}{2\delta E^2}\right) \quad (12)$$

Here,  $E$  is the energy at which the a single photon is emitted,  $P_{\text{absorption}}$  is the probability it is absorbed, and  $E\gamma(v,h)$  is the energy of the absorbed photon in terms of its relative velocity  $v$  and height  $h$  described above. The emitted photon has an uncertainty in its energy  $\delta E$  from the uncertainty principle due to the finite lifetime of the excited state.

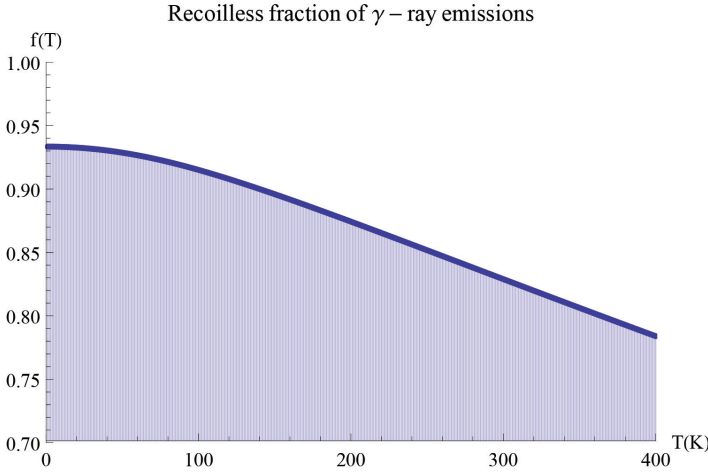


Figure 1. Temperature dependence of Mössbauer effect in  $^{57}\text{Fe}$

## 2.2 Detection of the Mössbauer absorption events

We now consider some of the practical details relevant for the choice of the geometry of the source and absorber. Suppose we have two cylindrical samples of similar dimensions both containing excited  $^{57}\text{Fe}$  nuclei of radius  $R$  and height  $h$  placed a distance  $L$  apart. We will call one the “source” and the other the “absorber”. The absorber is placed above the source, with both being normal to each other. Assume that the gamma rays emitted by the source through  $^{57}\text{Fe}^* \rightarrow ^{57}\text{Fe} + E_\gamma$  all travel a path that is normal to the surface and the absorber. The geometry is depicted in Fig.(2). The intensity at the absorber is proportional to

$$I_0 = \frac{\pi R^2 A_R}{\pi L^2} \quad (13)$$

where  $A_R$  is the activity of the source.

The emitted gamma-rays will interact with  $^{57}\text{Fe}$  nuclei in the absorber. The most prominent interactions are the Mössbauer effect (Möss), photoelectric absorption (PE), and coherent scattering (scatt); the attenuation of the photon intensity as it passes through the absorber  $\delta I$  can be written as

$$\delta I = I_0 \exp(-nH\sigma_{\text{Total}}) \quad (14)$$

where  $n$  is the atomic number density,  $\sigma_{\text{Total}}$  is the sum of the cross sections of the interactions mentioned above ( $\sigma_{\text{Total}} = \sigma_{\text{Möss}} + \sigma_{\text{PE}} + \sigma_{\text{scatt}}$ ), and  $H$  is the thickness of the absorber. Since we are interested in the gamma-rays absorbed by the absorber and then re-emitted by the Mössbauer effect, we will place our detectors adjacent to the absorber, outside of the path traveled by gamma-rays emitted by the source. We then choose  $H$  to be thin enough that Mössbauer photons

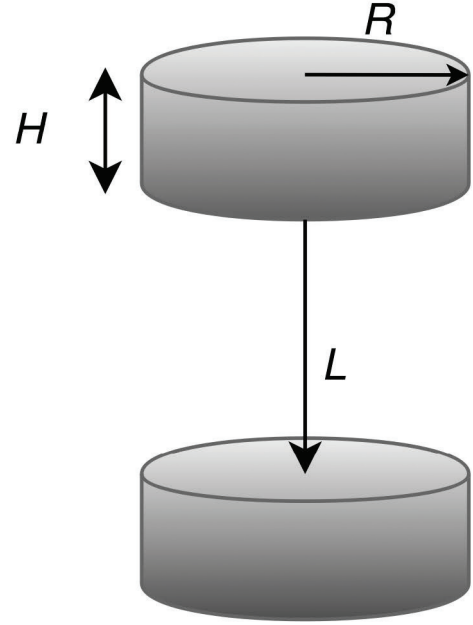


Figure 2. Geometry of the the emitter-absorber pair

will come from all nuclei in the absorber. Let us assume that our detector is some cylindrical disk flanking the absorber from all sides, as shown in Fig.(3). The size and distance of the detector is not important if we assume perfect detection and that all redirected radiation from the absorber is emitted normal to the inner surface of the detector.

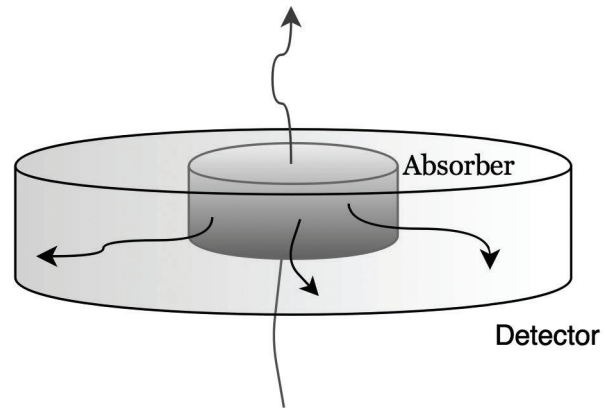


Figure 3. Depiction of the Absorber-Detector geometry

The Mössbauer intensity redirected by the absorber is proportional to

$$I_0 (1 - e^{-nH\sigma_{\text{Total}}}) \cdot \frac{\sigma_{\text{Möss}}}{\sigma_{\text{Total}}} \quad (15)$$

Assuming that on average the redirected radiation is re-emitted from the center of the absorber, the intensity received by the detector is proportional to  $\exp(-nR\sigma_{\text{Total}})$ .

The cross-sections will depend on the energy of the photons and the type of elemental medium in which they are traveling.

The cross section for the photoelectric effect  $\sigma_{PE}$  is given by

$$\sigma_{PE} = 2r_o \cdot \frac{hc}{E_\lambda} \cdot f_2 \quad (16)$$

where  $r_o$  is the classical electron radius,  $h$  is Planck's constant,  $c$  is the speed of light, and  $f_2$  is a complex scattering factor that can readily be found in tabulations in online databases or printed materials. The coherent Rayleigh scattering cross-section averaged over all possible collision angles can be written as

$$\sigma_{scatt} = \frac{2}{3}\pi^5 \cdot \frac{r^6}{\lambda^4} \cdot \left(\frac{n_r^2 - 1}{n_r^2 + 2}\right)^2 \quad (17)$$

$r \ll \lambda$ , where  $n_r$  is the index of refraction of the material,  $\lambda$  is the wavelength of the photon, and  $r$  is the radius of the scattering particle. Empirical and tabulated measurements of the coherent scattering cross section show it to be two orders of magnitude smaller than the photoelectric absorption cross-section in the same energy range and five orders of magnitude smaller than the Mössbauer effect cross-section for  $^{57}\text{Fe}$ ; the coherent scattering cross-section could be considered negligible. We used the Lawrence Berkeley Lab's (LBL) Center for X-ray Optics' atomic scattering files [9], the National Institute of Standards and Technology's (NIST) XCOM: Photon Cross Sections Database [12] or X-Ray Form Factor, Attenuation, and Scattering Tables [14] to directly obtain the cross-sections for the photoelectric effect and for coherent scattering. The Mössbauer effect cross-section is taken from [3].

### 2.3 Loss of gamma ray photon intensity between the emitter and absorber

In this experiment, we have a few options for what the space between the emitter and receiver will contain. These options include a vacuum, hydrogen gas, and helium gas. A vacuum would allow for the maximum intensity to reach the receiver. However, a vacuum requires the presence of two material windows, so we also looked into how much gamma ray photon intensity would be lost if we were to use a gas instead. We were also interested in how much loss would occur with the rays passing through a thin, strong material which can withstand a 1 bar pressure difference. As it turns out, the aluminum used in soda cans is known to be quite strong and highly optimized for a high strength-to-thickness ratio. The essential equation to evaluate the tradeoffs for different options is the Beer-Lambert Law

$$I = I_o e^{-(\frac{\mu}{\rho})\rho l} \quad (18)$$

where  $(\mu/\rho)$  is the mass attenuation coefficient. Using the NIST XCOM database [13], it is easy to find this number for all three elements. The density of aluminum is well known. We used NIST's Standard Reference Database for the density of Hydrogen and Helium at 295 K and 1 bar.

To find how much aluminum the gamma rays would go through, we measured several soda cans and found their average width to be about  $1.8 \times 10^{-4}$  m. All of these parameters were plugged into the Beer-Lambert Law and the results are shown in Table (1). Out of H and He, He allows for the most gamma rays to pass through with only a 0.4% intensity loss. In addition, helium gas is safe to use and is a practical choice.

Z	$\mu/\rho$ [ $\text{m}^2/\text{kg}$ ]	$\rho$ [ $\text{kg}/\text{m}^3$ ]	$l$ [m]	$I_f$
H	.03774	.082	30	.985 $I_o$
He	.02116	.16311	30	.996 $I_o$
Al	.8689	2700	$1.8 \times 10^{-4}$	.158 $I_o$

Table 1. This table shows the parameters used in the Beer-Lambert Law equation for hydrogen, helium, and aluminum. In its last column, it shows the fraction of the original intensity that is let through each material.

### 2.4 Improving efficiency between emission and absorption using x-ray mirrors

To maximize the signal received and thereby maximize data collection, it is desirable to encase the emitter, absorber, and intervening space with a mirror which will maximize the amount of photons that reach the absorber. Doing this will collect some photons which would otherwise escape through the non-reflective boundaries of the experiment, and redirect them to the absorber. X-rays reflect only at glancing angles measured from the inbound light to the surface of reflection. However, careful choice of reflective material can yield an increase in the amount of photons that reach the absorber. Wolter optics, a series of nested curved mirrors, would likely provide the best signal, but the cost of manufacturing such optics outweighs the benefit of their use in this application [17].

A more cost-effective solution is to encapsulate the experiment within a cylindrical mirror created from glass with the inner surface coated in a layer of a high-density material with high x-ray reflectivity (illustrated in Fig. (4)). When choosing a material for coating the cylinder, maximizing the index of refraction of the material for the energy of the emitted photons (14.4 keV) is the priority. Maximization of the index of refraction will yield a maximized angle from which photons striking the mirror will be reflected and continue to pass down the cylinder to be received by the absorber.

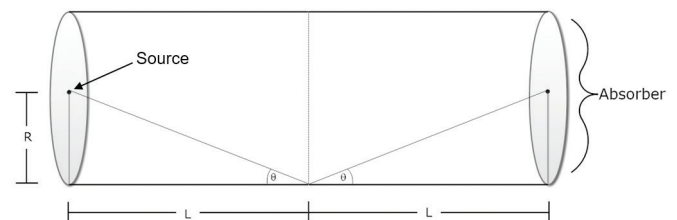


Figure 4. Geometry of mirror apparatus

The index of refraction of a material is parametrized as:

$$n = 1 - \delta - i\beta \quad (19)$$

where  $\delta$  is the decrement of refraction, and  $\beta$  is the absorption index of the material. The index of refraction can be expressed as a function of photon energy and material by the following form:

$$n = 1 - \delta - i\beta = 1 - \frac{r_0 \lambda^2 N}{2\pi} f_0 \quad (20)$$

where  $r_0$  is the classical electron radius,  $\lambda$  is wavelength,  $N$  is the atomic number density of the material, and  $f_0$  is the atomic scattering factor, as described by Gullikson [7].

$$f_0 = f_1 + if_2 \quad (21)$$

The atomic scattering factor for a given material has both real and imaginary parts  $f_1$  and  $f_2$ . Henke, Gullikson, and Davis have cataloged these values for all elements at photon energies ranging from 50–30,000 eV [1].

Total external reflection occurs at a critical angle which follows from Snell's law and is given by:

$$a_c = \sin^{-1} \left( \frac{n_2}{n_1} \right) \quad (22)$$

Hence, the glancing angle is:

$$\theta = \cos^{-1} \left( \frac{n_2}{n_1} \right) \quad (23)$$

When the medium through which the approaching light is close to that of a vacuum, such as in a gas, the index of refraction of that medium is much lower than that of the mirror surface and can be treated as approximately one. In this case, the glancing angle is:

$$\theta = \cos^{-1} (n_2) \quad (24)$$

The goal is to maximize the glancing angle to maximize photons received by the absorber. The chamber for the experiment should be filled with a low density uniform gas, such as the helium filled apparatus used by Pound and Rebka [15]. Assuming the index of refraction of the gas inside the chamber is approximately one, candidates for the mirror coating can be determined.

Good candidates for a reflective coating are those with a high density. Several candidates which would maximize the glancing angle are iridium and tungsten. The most effective of these choices is iridium, which would give a glancing angle of 0.0058 radians. However, tungsten gives a glancing angle of 0.0056 radians [1]. Since tungsten is significantly less expensive than iridium, it could be considered as a substitute for iridium if costs are a restraint.

The previous sections have discussed the physics of the Mössbauer effect, its use to search for the gravitational redshift from curved spacetime, the conceptual design of the experiment employing moving sources to induce a Doppler

shift that cancels the gravitational effect to bring the photon energy back into resonance, and some of the technical and safety issues associated with the practical design of such an experiment. In the rest of the paper we discuss the relevant concepts needed to understand how to add photon spin to this experiment in order to test the possible spin dependence of gravity.

## 2.5 Decay of $^{57}\text{Fe}$ source intensity

The source intensity is proportional to the activity of the primary  $^{57}\text{Co}$  source which feeds the excited state of interest in  $^{57}\text{Fe}$ . The equation for decay of an isotope is:

$$N(t) = N_0 e^{-\lambda t} \quad (25)$$

where  $N$  is the number of atoms of the isotope available after time,  $t$ , from the initial number of atoms  $N_0$ .  $\lambda$  is the decay constant given by the half-life of the isotope,  $T$ , given by the equation:

$$\lambda = \frac{\ln 2}{T} \quad (26)$$

The equation for decay can also be written in terms of activity given that activity is proportional to the number of atoms ( $A = N\lambda$ ), so the equation for decay in activity is:

$$A = A_0 e^{-\lambda t} \quad (27)$$

where  $A_0$  is the initial activity of the isotope and  $A$  is the activity over time,  $t$ . So since intensity is proportional to activity the loss of source intensity due to decay is shown by the equation:

$$I = I_0 (1 - e^{-\lambda t}) \quad (28)$$

The half-life of  $^{57}\text{Co}$  is 271.80 days [16], which is long enough to operate the experiment over a reasonable time before needing to replace the source.

## 2.6 Safety precautions

As with any experiment, it is important to understand and account for safety and health hazards associated with radioactive sources of material. Since the radiation being measured consists of X-ray photons (14.1 keV), it is important to pick a material to safely attenuate the emissions. With its availability, density, and strong attenuation properties, lead is a good choice of material to attenuate the photons.

For 14.1 keV X-ray emissions, lead has a mass attenuation coefficient around 100 cm<sup>2</sup>/g [13]. This means for safe attenuation of the radioactive emissions (a factor of 10<sup>-5</sup>), the particles would need to travel through about 2 mm of lead. If we surround the sample and the experiment such that any X-ray emitted travels through at least this thickness of lead, the surrounding area will be effectively safe from harmful radiation.

### 3. ADDITION OF SPIN TO THE POUND-REBKA EXPERIMENT

To explain how to generate and manipulate the photon spin angular momentum, we must first describe how one defines and manipulates the angular momentum of matter particles.

#### 3.1 Energy level splitting of magnetic moment in a magnetic field

We first review the fundamental concept of quantum mechanical spin and its connection with the magnetic moments of elementary particles. A magnetic dipole moment  $\mu$  is produced by current flowing in a loop, and is defined by the product of the current and the area of the loop.

Consider first a classical physics model. An object with a magnetic moment feels a torque if it is placed in an external magnetic field. The torque acting on the magnetic moment can be found by cross multiplying the magnetic moment  $\mu$  and the magnetic field vector  $B$ .

$$\vec{\tau} = \vec{\mu} \times \vec{B} \quad (29)$$

The size of the magnetic moment of a charged particle is usually written as:

$$\mu = g \frac{e\hbar}{2m} J \quad (30)$$

where  $m$  is the particle's mass,  $J$  is the particle's spin,  $e$  is its electric charge, and  $g$  is the so-called gyromagnetic ratio (which from theory is equal to 2 for a point particle with no internal structure). The  $^{57}\text{Fe}$  nucleus has a gyromagnetic ratio of 0.1806 in its ground state [2]. Magnetic moments are often expressed in terms of the nuclear magneton  $\mu_N$ :

$$\mu_N = \frac{e\hbar}{2m_p} = 5.050783 \times 10^{-27} \text{ J/T} = 3.152452 \times 10^{-8} \text{ eV} \cdot \text{T}^{-1} \quad (31)$$

For the case of  $^{57}\text{Fe}$ , we find

$$\mu_{Fe} = g \frac{e\hbar}{2m_p} J = g\mu_N J \quad (32)$$

where  $\mu_N$  is the nuclear magneton. For the  $^{57}\text{Fe}$  isotope ground state, the spin of the nucleus is  $1/2$  [4].

$$\mu_{Fe} = g\mu_N J = 5.75192609 \times 10^{-8} \text{ eV} \cdot \text{T}^{-1} \quad (33)$$

We can now find the magnetic potential energy of the magnetic moment. The energy is given by the dot product of the magnetic moment and the magnetic field:

$$E = -\vec{\mu} \cdot \vec{B} \quad (34)$$

where  $E$  is the energy of the magnetic moment. Plugging in for  $\mu$  gives us

$$E = -\vec{\mu} \cdot \vec{B} = -(5.75192609 \times 10^{-8} \text{ eV} \cdot \text{T}^{-1})B \quad (35)$$

The magnetic moment will have this magnetic potential energy when placed within the magnetic field. This value is also how much the energy of the atomic levels of the  $^{57}\text{Fe}$  isotope will be shifted.

The directions of the magnetic moment and the magnetic field matter here; the orientation of the magnetic moment relative to the magnetic field will determine how the electron energy levels will split. The energy will be at its minimum when these are parallel and will be at its maximum when these point in opposite direction. The difference in energy between this minimum and maximum is

$$\Delta E = 2\mu B \quad [6] \quad (36)$$

#### 3.2 Dependence on $T$ assuming magnetized iron foil

For  $^{57}\text{Fe}$  nuclei in an external magnetic field, there are two distinct states corresponding to alignment or anti-alignment of nuclear spin. As indicated earlier, these two states have different energies; thus, we can estimate the average nuclear polarization by computing the Boltzmann factors for the relative probabilities of the aligned state,  $E_1$ , and the anti-aligned state,  $E_2$ .

$$\frac{Pop(E_1)}{Pop(E_2)} = \exp\left(\frac{E_2 - E_1}{kT}\right) = \exp\left(\frac{\Delta E}{kT}\right) \quad (37)$$

Polarization,  $P$ , is defined as follows:

$$P = \frac{Pop(E_1) - Pop(E_2)}{Pop(E_1) + Pop(E_2)} \quad (38)$$

Thus  $P = 1$  implies all of the nuclei are aligned, while  $P = -1$  implies they are all anti-aligned. A little algebra gives

$$P = \frac{e^{\frac{\Delta E}{kT}} - 1}{e^{\frac{\Delta E}{kT}} + 1} \quad (39)$$

### 3.3 Emission & angular momentum conservation

The total angular momentum  $\vec{J}$  is defined as the sum of the spin angular momentum,  $\vec{s}$ , and the orbital angular momentum,  $\vec{l}$ .

$$\vec{J} = \vec{s} + \vec{l} \quad (40)$$

The decay of a radioactive atom by gamma emission changes the atomic state from an excited state to a lower energy state with an emission of a photon. In the decay of the atomic state and the emission of the photon, both the total angular momentum and the total parity of the system must be conserved. These two conservation laws control the possible properties of the emitted photon.

#### 3.3.1 Conservation of angular momentum

From conservation of total angular momentum,

$$\vec{J}_{\text{initial}} = \vec{J}_{\text{final}} + \vec{J}_{\gamma} \quad (41)$$

where  $\vec{J}_{\text{initial}}$  is the angular momentum vector of the initial atomic state,  $\vec{J}_{\text{final}}$  is the angular momentum vector of the decayed atomic state, and  $\vec{J}_{\gamma}$  is the angular momentum of the emitted photon.

Quantum mechanics states that angular momentum is quantized. The magnitude of the angular momentum  $\vec{J}$  is  $\sqrt{j(j+1)}\hbar$ , where  $j = 0, 1/2, 1, 3/2, \dots$  are the possible values for the total angular momentum quantum number. Using this along with the quantum laws of angular momentum addition, we find the possible values of the total angular momentum of the final state:

$$j_{\text{decayed}} = |j_{\text{initial}} - j_{\gamma}|, |j_{\text{initial}} - j_{\gamma}|, \dots, j_{\text{initial}} + j_{\gamma} - 1, j_{\text{initial}} + j_{\gamma} \quad (42)$$

This shows that the possible values of  $j_{\text{decayed}}$  increase from  $|j_{\text{initial}} - j_{\gamma}|$  to  $j_{\text{initial}} + j_{\gamma}$ .

Only one component of the total angular momentum vector can possess a definite value in quantum mechanics. In our case we will choose the axis of quantization of the system to lie along the z-axis defined by the path of the photon between emitter and absorber. The possible values for the z component of the total angular momentum are  $m\hbar$ , where  $m$  is the magnetic quantum number with values ranging from  $-j$  to  $j$  by increments of 1. So, conservation of angular momentum in the z-direction can be expressed as

$$m_{\text{final}} = m_{\text{initial}} - m_{\gamma} \quad (43)$$

#### 3.3.2 Conservation of parity

A parity transformation consists in the inversion of all of the coordinate axes. The parity quantum number associated with this transformation on a quantum mechanical state, represented by  $\pi$ , can have only two values: either  $-1$  or  $1$ . The electromagnetic interaction which generates and absorbs the photon conserves parity symmetry, and therefore the total parity of the system is a conserved quantum number. Parity is a multiplicative quantum number. Conservation of parity states therefore implies that the initial parity must be equal to the product of the parity of the final atomic state and the parity of the emitted photon

$$\pi_{\text{initial}} = \pi_{\text{final}} \cdot \pi_{\gamma} \quad (44)$$

The parity of a particle moving in an atomic orbital depends on the orbital angular momentum azimuthal quantum number  $l$ .

$$\pi = (-1)^l \quad (45)$$

Therefore conservation of parity in the case of an emitted photon may be expressed as

$$(-1)^{l_{\text{initial}}} = (-1)^{l_{\text{final}}} \cdot \pi_{\gamma} \quad (46)$$

We now have the selection rules which determine the possible spins and parities of the emitted photon in terms of the properties of the initial and final states of the nucleus.

### 3.3.3 Application of conservation laws to the emission of a photon by polarized $^{57}\text{Fe}$ nuclei

We now apply these general rules to the specific case of the particular transition of interest to this work. The emission of a photon by the decay of  $^{57}\text{Fe}$  is a mixed electric quadrupole transition and magnetic dipole transition. The emitted photon has a net angular momentum,  $j_{\gamma}$ , of 1 and an intrinsic parity,  $\pi_{\gamma}$ , of  $(-1)^l$  for  $E_2$  transition and  $(-1)^l + 1$  for  $M_1$  transition.

So, substituting into Eqn.(46), conservation of parity gives

$$(-1)^{l_{\text{initial}}} = (-1)^{l_{\text{final}}} \cdot (-1)^{l_{\gamma}+1} \quad (47)$$

The decay of the excited state of  $^{57}\text{Fe}$  involves the decay from an initial atomic state with an azimuthal quantum number of  $\pm 3/2$  to a final state with an azimuthal quantum number of  $\pm 1/2$ . Through substitution, this gives

$$(-1)^{\pm 3/2} = (-1)^{\pm 1/2} \cdot (-1)^{l_{\gamma}+1} \quad (48)$$

The photon has an orbital angular momentum number  $l_{\gamma}$  of 0. The photon's parity is then calculated to be  $(-1)^l$ , or  $-1$ , which agrees with the known intrinsic parity of the photon. The photon has total angular momentum,  $J_{\gamma}$ , of  $s$ , as  $l_{\gamma}$  equals zero, where  $s = 1$ .

This means that the spin and parity of the emitted photon agree with the conservation laws and produces a photon with a known angular momentum dependent upon the photon's spin.

The polarization of the emitted photon can then be either aligned or anti-aligned with the magnetic field based upon the alignment of the iron sample. The experimental question then becomes how to reverse this polarization. We describe the available techniques for doing this.

### 3.4 Reversal of angular momentum using magnetic resonance

Nuclear magnetic resonance (NMR) can be used to invert the spin of the excited iron, thereby changing the polarization of the emitted gamma ray. A powerful static magnetic field can be used to polarize the iron nuclei along the direction of the field. Since the decay product of  $^{57}\text{Co}$  is  $^{57}\text{Fe}^*$  which has a spin of  $3/2$ , the Zeeman effect occurs and the energies of the different states are split. A slight perturbation to the system in the form of a radio wave at the correct frequency can flip the spin from aligned to antialigned with the field.

The frequency of precession is the Larmor angular frequency described by the Larmor Equation:

$$\omega = \gamma \mathbf{H} \quad \text{and} \quad \gamma = \frac{\mu}{I} = \frac{g\beta}{\hbar} \quad (49)$$

where  $\gamma$  is the gyromagnetic ratio (1.382 MHz/T),  $I$  is the nuclear angular momentum,  $\mathbf{H}$  the magnetic field strength,  $g$  the nuclear g-factor unique to the nuclei (3.276 for  $^{57}\text{Fe}^*$ ), and  $\beta = 3.152451 \times 10^{-8}$  eV/T is the unit of magnetic moment called the nuclear magneton.

Nuclei at room temperature will be randomly oriented according to a Boltzmann distribution:

$$\frac{N^-}{N^+} = e^{-\frac{\Delta E}{kT}} \quad (50)$$

However, when a magnetic field ( $B_0$ ) is applied, alignment with the field becomes thermodynamically favored. Energy levels in the field are thus:

$$\Delta E = -\mu B_0 = -m\hbar\gamma B_0, \quad m = -\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}, \text{ or } \frac{3}{2} \quad (51)$$

Substituting for  $\gamma$ ,  $\Delta E = g\beta B_0$  and using the energy of a photon  $E = fc$ , the required photon frequency is the following:

$$f = \frac{g\beta B_0}{\hbar} \quad (52)$$

One must therefore choose a temperature and a magnetic field environment which both leads to a large nuclear polarization and also a practical frequency for spin reversal. Natural iron in the ferromagnetic state has a very large internal magnetic field which makes the hyperfine levels visible at room temperature, and the hyperfine spectra have been measured for a very broad range of iron-containing materials. However, it is not practical to flip this internal magnetic field by external means. Therefore, in this material, one would need to induce spin flips by absorption of photons of the right frequency as shown above [5].

This method is the usual technique used to flip nuclear spins and is used in magnetic resonance imaging. However for our experiment it comes with a severe disadvantage. The problem is that the Mössbauer photon now has an extra contribution to its energy from the extra energy of the transition between the magnetic sublevels. Therefore, the photon is no longer in resonance with the absorber. This would not be a problem if the exact same energy level splitting of magnetic sublevels was present in the absorber. However, this equality might demand a level of accuracy of the magnetic fields in the two separate samples, which is difficult to achieve. We are then led to consider an alternative method for sensing the angular momentum dependence of the gravitational redshift of the photon.

### 3.5 Use of the Faraday effect

Consider producing a photon which is not in a definite state of spin angular momentum about the z-axis, but is rather in an

equal quantum superposition of the two angular momentum projections along  $z$ . Such a photon state has a name: it is called linear polarization. We could therefore conduct the spin-dependent experiment in a slightly different way. Assume we can arrange the Mössbauer transition to generate such a linearly polarized photon state. If there is a spin-dependence to the gravitational redshift, the plane of polarization of this radiation will rotate from its original orientation as the energy, and therefore the quantum mechanical phase of the two different components of the photon state become slightly different. The sign of the effect flips when the photons travel in the opposite direction of the gravitational field. Therefore, we can alternatively search for a rotation of the plane of polarization of the photons instead.

### 3.6 Other possible nuclei

For the original Pound-Rebka experiment, they used  $^{57}\text{Fe}$ , but very little is stated in the Pound-Rebka experiment as to why specifically this isotope of iron was chosen, and what led to that decision. In this section, we explore the possibility of using a different nucleus to conduct our experiment with higher accuracy. To consider this, we must take every nucleus that possesses a Mossbauer transition and take a survey of their properties to find the best viable option while also considering practical availability. To do this we construct a spreadsheet detailing each isotope with its abundance (%), excited state energy (keV), and excited half-life (ns). We also make note of any peculiarities such as radioactivity or unknown values, as these unknowns would cause unpredictable results in the experimental process. Using this spreadsheet one can filter the results using a figure of merit which applies values to each transition, isotope, and nucleus in order to determine its comparative usefulness for our purpose. In this case we take the product of the excited state energy times the excited half-life times the square root of the isotopic abundance,

$$E_{\text{excited}} \cdot t_{1/2} \cdot \sqrt{A} \quad (53)$$

where  $E$  is the excited state,  $t$  is the half-life of the excited state, and  $A$  is the isotopic abundance. This value is proportional to the ratio of the energy width of the resonance,  $\delta E$ , and the gamma energy,  $E$ . Assuming we need a minimum ratio, first we set the minimum value for the figure of merit to be the minimum value which was calculated from the  $^{57}\text{Fe}$  (approximately 200). Then, we sort through the results from other nuclei, and disregard any that either has no second transition, or for which the second transition does not meet the results set by the figure of merit. This leaves only  $^{57}\text{Fe}$  and  $^{73}\text{Ge}$  as viable options, and Ge gives a figure of merit upwards of 10,000, nearly 100 times that found for Fe. This is mainly due to its very long half-life.

## CONCLUSION

In this collective research project, we have considered some of the important issues of principle and some of the relevant practical details for a future experiment to search

for the possible spin dependence of the gravitational redshift using the Mössbauer effect with polarized photons. We have described the important physical effects involved in the phenomena themselves and outlined some of the important issues that must be considered for a real experiment. We conclude that there is no issue of principle or safety issue which forbids such an experiment from being realized. We have identified some of the important problems that must be addressed to realize the new feature of the proposed experiment, namely the measurement of the polarization dependence. We have identified a possible new approach based on the use of transversely polarized light rotation which could be a good choice for this experiment, as it is possible to measure this rotation of the plane of polarization without changing the energy of the source of the absorber (as required in methods which employ a spin flip of some type).

Two main steps need to be taken to realize this experiment. First, one must analyze the various sources of systematic errors with one of the methods in mind and convince oneself that there is no experimental control parameter that is impossible to achieve. In addition, there must be enough progress on the theory of exotic spin-dependent effects in gravity to have some idea of the expected size of a possible effect as this can strongly influence the choice of a specific nucleus, although in our case we used data from the very well-understood transition in iron that has been so heavily used in Mössbauer studies.

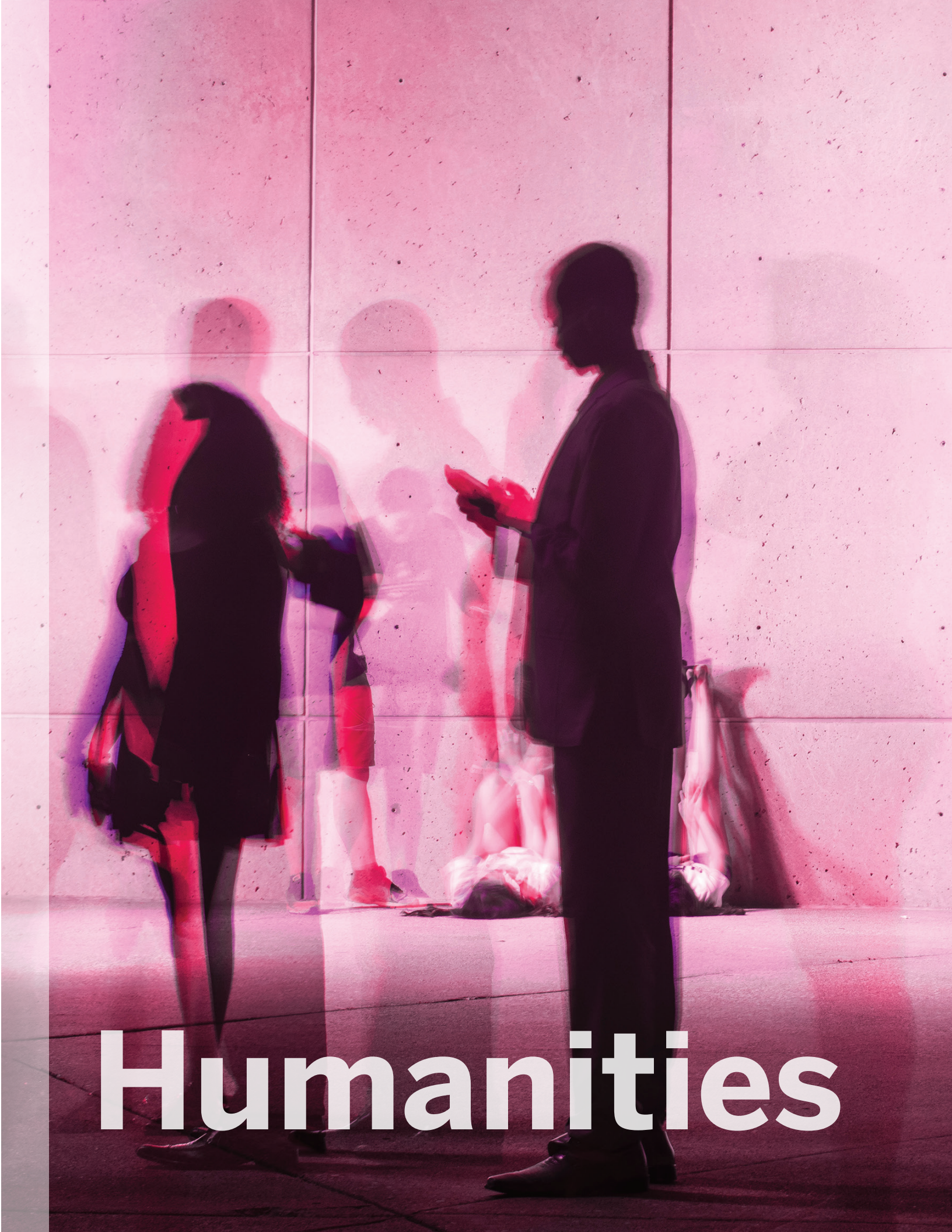
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# Humanities

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# On the Edge of a New Perception: The Art of Moran and Watkins

**Lauren Ehrmann**

Faculty Mentor: Dr. Christoph Irmscher, Department of English *Indiana University*

Near the end of the nineteenth century, technological advances had rendered it less perilous to cross the continent, and the United States began to consider in earnest the newly acquired and more sparsely populated territory on the other side of the Rocky Mountains known as the West. Scientific expeditions and entrepreneurial ventures began to flock westward, and with them came artists. Art was a central part of the process of understanding the West and conveying the nature of that portion of the nation to more populated areas in the East. The visual documentation of the American West has become an indelible part of American identity, and the artists first tasked with recording the landscapes that they encountered in the West faced important questions about the role of documentation. This has shaped how Americans view the West and how we view ourselves to this day. *The Grand Canyon of the Yellowstone* by Thomas Moran and *The Grizzly Giant* by Carleton Watkins are two artworks that provide a valuable lens through which to view these shifting perspectives on the role of art in the documentation, presentation, and preservation of landscape in the late nineteenth century.

In 1871, Ferdinand V. Hayden, a preeminent geologist and explorer, petitioned the U.S. government for funds to make an expedition into the region of the United States today known as Yellowstone National Park and take a geological survey of the area.<sup>1</sup> He was accompanied by a large team, composed primarily of scientists, but among the members of his entourage was also the famous American landscape painter Thomas Moran.<sup>2</sup> Moran, as the expedition's painter, was charged with creating scenes that accurately portrayed the sights he saw, particularly with respect to color. However, Moran also worked within the sublime landscape tradition that was well-established in the United States, and it is known that he altered many details of the landscapes he saw to make them more visually dynamic, and thus capture the spirit of the landscape rather than the landscape itself. This intersection of the scientific and the sublime puts the paintings produced during this expedition, particularly *The Grand Canyon of the Yellowstone*, at the heart of the questions surrounding the use of objectivity and emotion in documentation at the time.

In the late nineteenth century, the United States was increasingly turning toward science as the guiding ideal



*The Grizzly Giant* by Carleton Watkins

for a functioning society. Technological advancements such as electricity, the telegraph, and the steam engine were pushing American life forward, and Americans began to view technology, and by extension science, as the driving force behind the country's progress.<sup>3</sup> Amid this wave of technological innovations, a new medium emerged that would change the way Americans viewed the world forever: photography. In the decades following its invention, photography was viewed not as an art form but as a method of objective and accurate visual documentation.<sup>4</sup> Documentation had previously been the realm of fine art, especially painting, and now artists found themselves struggling to find the appropriate language for the representation of space. With straightforward

<sup>1</sup> "1871 Hayden Expedition," *Yellowstone National Park*, accessed October 23, 2016, <http://www.yellowstonenationalpark.org/blog/yellowstone-history/1871-hayden-expedition/>.

<sup>2</sup> Angela L. Miller, Janet Catherine Benlo, and Jennifer L. Roberts, *American Encounters: Art, History, and Culture* (London: Prentice Hall, 2008), 303.

<sup>3</sup> *Ibid.*, 300.

<sup>4</sup> *Ibid.*, 303

documentation now consigned to the realm of science, artists began to emphasize the “atmosphere of spectacular nature,”<sup>5</sup> or attempt to capture the experience of viewing nature rather than simply objectively reproduce it. They thus realized that even this traditional medium, while not inherently “scientific,” could contribute to the new vogue for accuracy.

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In his painting *The Grand Canyon of the Yellowstone*, Moran utilizes both documentation and emotion. Even though there was a photographer on the expedition, Moran still had a commitment to scientific documentation in his paintings because only a painter could capture color.<sup>6</sup> As Hayden himself says in the preface to a book of chromolithographs of Moran’s paintings, “all reproductions of landscape scenery must necessarily lose the greater part of their charm when deprived of color; but of any representation in black and white of the scenery of Yellowstone it may truly be said that it is like Hamlet with the part of Hamlet omitted.”<sup>7</sup> Moran certainly emphasized color in the composition, depicting an enormous range

of colors from deep purples to chalky yellows streaking the Canyon walls; his painting is an invaluable scientific document of the specific pigments found within the Yellowstone Canyon.<sup>8</sup>

*The Grand Canyon of the Yellowstone* makes a further argument for science in a symbolic sense. Moran depicts four figures, two of which are standing on a ledge overlooking the canyon. These figures serve many artistic purposes: they preserve a sense of scale and allow the viewer to imagine herself in the scene, viewing the landscape as if she were beside the figures depicted. But they also serve an allegorical purpose: one figure is a member of the geological survey while the other is a Native American.<sup>9</sup> Here, Moran symbolizes a peaceful handoff between the caretakers of the land. The Native American, a former custodian of this wilderness, faces the viewer while the scientist looks out across the landscape, already claiming it as his to explore, use, and protect. Moran makes a strong argument for science by allowing a member of a scientific survey to represent the progress and future of the American landscape.



*The Grand Canyon of the Yellowstone* by Thomas Moran

<sup>5</sup> Sarah Wilson, “A Photograph and a Painting: William Henry Jackson, Thomas Moran, and Capturing Yellowstone Vistas,” *Wordpress* (blog), February 11, 2016, <https://theamericanistdiversion.com/2016/02/11/a-photograph-and-a-painting-william-henry-jackson-thomas-moran-and-capturing-yellowstone-vistas/>.

<sup>6</sup> Ferdinand V. Hayden, *The Yellowstone National Park and the Mountain Regions of Idaho, Nevada, Colorado and Utah*, (L. Prang and Company, 1876), III.

<sup>7</sup> *Ibid.*

<sup>8</sup> Thomas Moran, 1872, *The Grand Canon of the Yellowstone*, Oil on canvas, Washington DC: Smithsonian American Art Museum.

<sup>9</sup> Miller, *American Encounters*, 303.

Scientific accuracy, however, is not Moran's sole goal, or even his primary goal. In a letter from Moran to Hayden, he states that with *Canyon* he hopes to "produce a most decided sensation in Art Circles;"<sup>10</sup> in other words, Moran hopes to emphasize emotion (or "sensation") in this painting. To that end, he turns to the time-honored tradition of the sublime. Edmund Burke, in his book *A Philosophical Enquiry into the Origin of our Ideas of the Sublime and Beautiful*, defines the sublime as "whatever is fitted...to excite ideas of pain and danger, ... whatever is in any sort terrible ... is a source of the *sublime*, that is, productive of the strongest emotion which the mind is capable of feeling."<sup>11</sup> The sublime is the union of terror and beauty, a perfect visual language for conveying the excitement and discomfort of progression (in competition with photography) as well as tying the composition to a much older artistic tradition. In *Canyon*, Moran uses, to great effect, many of the elements which Burke outlines in his book as producing the sublime. The sublime centers around terror, and Burke lists "vastness" and "infinity" as two devices by which this terror may be conveyed.<sup>12</sup> Moran expertly depicts a heady sense of vastness with the high vantage point and the large size of the canvas. He presents a seemingly infinite vista by fading the edges of the landscape at the horizon line, suggesting that the landscape presented to the viewer could well go on forever. Furthermore, Moran creates a heightened sense of terror and appeals to the viewer's instinct of self-preservation by placing the two central figures in the painting at the edge of a sheer vertical drop – the viewer puts herself in the shoes of these figures and experiences the landscape from the viewpoint of a cliff edge.

Another cause of the experience of the sublime is irregularity and asymmetry,<sup>13</sup> both used by Moran in this composition. The edges and surface of Yellowstone Canyon are jagged and irregular, and a cluster of pine trees on the left of the composition creates asymmetry, despite the fact that no such asymmetry exists from this vantage point in real life – it was created by Moran to heighten the effect of the sublime. By using these elements, Moran supports the argument that a landscape is more than merely the sum of its parts. To truly capture a landscape, one has to do more than simply restate visual facts; an artist must capture what it feels like to stand in that space and convey some of that overwhelming and terrifying awe in his painting. By being able to incorporate emotional experience into documentation, painting makes itself perhaps an even more valuable record of a space than photography, in that it captures the experience of a landscape rather than mere

topography.

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While Moran's *The Grand Canyon of the Yellowstone* makes an argument for the continued importance of painting in landscape documentation, it is interesting to note that paintings such as Moran's from Yellowstone would not have been credible without the advent of photography. Without the objective proof of a photograph, the general public would not have accepted the fantastic scenery that Moran captures as anything more than a figment of his imagination.<sup>14</sup> One of the central roles of photographers in the West was proving that such places did indeed exist, and there is no better example of this than Carleton Watkins's famous *The Grizzly Giant*, a photograph of one of California's oldest giant sequoias taken in 1865. Like Moran, Watkins worked during the time shortly after the creation of photography, during which the definition of both art and documentation were in flux. Watkins was working with a new medium that was in the process of defining its role in the world of art and science. Viewed in this context, Watkins's work as a whole, and specifically *Grizzly Giant*, make an argument that photography belongs to both worlds: the world of empirical documentation and the world of artistic expression.

Just like Moran, Watkins expresses this argument by combining elements of scientific observation with sublime composition. Watkins was not involved in any official scientific expeditions or surveys at this time, but he was highly aware that by dint of his medium, much of the public would view his work as scientific, objective evidence of the existence of his chosen subject. He selected his subjects accordingly, choosing scenes which would have been believed to be impossible if not for the objective proof of photography, capturing the natural rock formations and botanical marvels of California that could not be found in the East.<sup>15</sup> *Grizzly Giant* is perhaps the best example of a photograph being used to convince people of the reality of the natural marvels of the West. Watkins used a custom-made camera that could expose "mammoth" glass plates in order to capture the expansive vistas of the West, and this technique meant that he was the first photographer ever to be able to capture the entirety of a giant sequoia on film.<sup>16</sup> The photo created awareness of the existence of these enormous trees to such a degree that Ralph Waldo Emerson said of *Grizzly Giant* that it "made the tree possible."<sup>17</sup> In other words, *Grizzly Giant* shows how the documentative, scientific property of photography lent the narrative of the West credibility and was instrumental

<sup>10</sup> Wilson, "A Photograph and a Painting."

<sup>11</sup> Edmund Burke, *A Philosophical Inquiry into the Origin of Our Ideas of the Sublime and Beautiful*, (Columbia University Press, 1958), 39.

<sup>12</sup> Ibid., 72-73.

<sup>13</sup> Ibid., 83.

<sup>14</sup> Joni Kinsey, *Thomas Moran's West: Chromolithography, High Art, and Popular Taste* (Lawrence: University Press of Kansas, 2006).

<sup>15</sup> "Art and the Hayden Geological Survey of 1871," *Smithsonian American Art Museum*, accessed October 27, 2016, [http://americanexperience.si.edu/wp-content/uploads/2015/02/Art-and-the-Hayden-Geological-Survey-of-1871\\_.pdf](http://americanexperience.si.edu/wp-content/uploads/2015/02/Art-and-the-Hayden-Geological-Survey-of-1871_.pdf).

<sup>16</sup> Mark Pimlott, *Without and Within: Essays on Territory and the Interior* (Rotterdam: Episode Publishers, 2007), 74.

to allowing the West to occupy its place in the American imagination at the time.

At first glance, *Grizzly Giant* appears to be a photograph whose only goal is documentation, concerned solely with getting the entirety of the massive sequoia into the frame without any other artistic considerations. But longer contemplation of the photograph will reveal that many artistic choices were made to cast this giant sequoia into the role in which Watkins wishes it to be viewed. Like Moran, when it comes to the artistic elements of this photograph, Watkins chooses to use the language of the sublime, the aesthetic format which has long colored the way Americans think about landscape and wilderness. Once again, Burke's *Enquiry* provides a useful framework with which to analyze the elements of the sublime that are present in this work of art. Like Moran, Watkins emphasizes vastness, one of the traits of the sublime, to create a feeling of both awe and terror.<sup>18</sup> He highlights the vastness of the giant sequoia by positioning a group of men in a cluster at the bottom of the tree to indicate scale, showing how truly massive the tree is. Another aspect of the sublime that Burke captures in this photograph is power.<sup>19</sup> The men positioned at the base of the tree are likely a group of explorers, one of whom is identifiable from another photograph taken of the same tree as Galen Clark, caretaker of this grove of giant sequoias and identifiable to Americans at the time as a famous "wilderness man."<sup>20</sup> Clark, a large man physically and an even larger figure in the American imagination, is nevertheless dwarfed in this photo by the tree, indicating the even greater power that the tree possesses.<sup>21</sup> Finally, the irregular and asymmetric are causes of feelings of the sublime.<sup>22</sup> Watkins clearly emphasizes the rough, irregular texture of the tree and its many twisted branches, which suggest that the tree has survived a calamity. Watkins is famous for using a wet plate development process that gave his photographs remarkable crispness, rendering the textures of the giant sequoia with great clarity.<sup>23</sup> Watkins' desire to connect this photograph to the tradition of the sublime is further made evident by his choice of title: *Grizzly Giant*. "Grizzly" points not only to the sublime irregularity of the build and texture of the tree, but also to the sublime feelings inspired by the memory of past storms which have shaped the tree. "Giant" evokes sublime ideas of vastness, infinity, and power; the tree Watkins depicts is giant not only in the physical sense but also in the way it plays upon

the viewer's ideas of the infinite. When a viewer sees an image of such a large tree, she immediately considers the vastness of time required for the tree to grow to such immense size, and in this way, Watkins portrays a tree that is vast both in size and in its place in history and the American psyche.

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The audience of *Grizzly Giant* would have likely encountered this photograph in a bound collection of prints of Watkins's photographs of the area,<sup>24</sup> although it was also on display in galleries. Interestingly, Moran's Canyon was distributed in much the same way, in a bound volume of chromolithographs printed by the famous chromolithographic company Prang and Co. To be able to make color reproductions of paintings through chromolithography was a relatively recent event in the art world, one which many of Moran's contemporaries were embracing as well as a means of making their artwork available to a wider market.<sup>25</sup> Moran began his career working in reproductions as an engraver, and this, combined with his awareness of the commercial success of photographic reproductions, is likely what inspired him to market the reproductions of his paintings.<sup>26</sup> What is most interesting about the bound volumes of Watkins and Moran is that they were marketed in much the same way. Surviving correspondence between Ferdinand Hayden and Prang indicates that Prang wanted to emphasize the scientific importance of the publication, which he achieved by having Hayden write an introduction to the volume as well as a commentary on each chromolithograph which positioned them within the context of the scientific expedition.<sup>27</sup> By framing the resulting volume of chromolithographs, entitled *Yellowstone National Park*, as both a scientific and an artistic work, Prang hoped to attract buyers of both markets. Watson did much the same in his bound works, representing his photos as documentation of scientific and natural wonders as well as works of fine art, the latter role emphasized by the quality and expense of the volumes produced.<sup>28</sup>

The consideration of distribution and marketing angles sheds light on a third factor which shaped the works of Moran and Watkins in addition to science and the sublime: enterprise; in other words, a preoccupation with the resources of the West. In the late nineteenth century, a mania for enterprise seemed to have swept the nation, and the West was one of the areas in which this

<sup>17</sup> Ibid., 72.

<sup>18</sup> Burke, *A Philosophical Inquiry*, 72.

<sup>19</sup> Ibid., 64-70.

<sup>20</sup> Elizabeth Hutchinson, "They Might Be Giants: Galen Clark, Carleton Watkins, and the Big Tree," in *A Keener Perception: Ecocritical Studies in American Art History*, ed. Alan Braddock, Christoph Irmscher, (University of Alabama Press, 2009), 117.

<sup>21</sup> Ibid., 116.

<sup>22</sup> Burke, *A Philosophical Inquiry*, 83.

<sup>23</sup> Pimlott, *Without and Within*, 72.

<sup>24</sup> Hutchinson, "They Might Be Giants," 114.

<sup>25</sup> Kinsey, *Thomas Moran's West*, 84.

<sup>26</sup> Ibid., 56.

<sup>27</sup> Ibid., 48.

<sup>28</sup> Ibid., 185.

<sup>29</sup> Peter Hales, "American Views and the Romance of Modernization," in *Photography in Nineteenth Century America*, ed. Martha Sandweiss, (Amon Carter Museum, 1991), 211.

<sup>30</sup> Nancy Anderson, "The Kiss of Enterprise: The Western Landscape as a Symbol and Resource," in *West as America*, ed. William Truettner, (Smithsonian Institution, 1991), 237-284.

entrepreneurial sentiment was focused.<sup>30</sup> Moran and Watkins chose to document the landscape of the West in such a way that conveyed both the resources present in the landscape and the ways in which the landscape itself was a resource.

At a strictly visual level, the matter of resources depicted in these paintings is fairly straightforward: both Moran and Watkins depicted extensive forests, indicating the wealth of lumber available in the American West and implying that other resources were equally plentiful. But the resource of the West that is the special focus of Moran and Watkins's work and is not immediately apparent because it is not one specific part of the scene they depict is the scene itself. The spectacular views of the West were themselves a resource.<sup>31</sup> Like miners headed to the gold rush or loggers seeking to gain money from the West's forests, Moran and Watkins helped themselves to the region's most valuable resource: its landscapes. Scenes of the West were wildly popular, and artists recognized that they, too, could profit from the resources of the West.<sup>32</sup> They mined the landscape using paintbrushes and cameras, and it yielded to them a profit that was both monetary and cultural. Framed in this way, it becomes evident that documentation of the West was shaped not only by scientific and artistic concerns, but also by an awareness of which compositions and scenes would be most popular with Eastern audiences.

The scenery of the West was valuable for another reason as well: it drew tourists in droves. By painting these scenes of the West and distributing them in more populated regions of the country, artists such as Moran and Watkins were instrumental in making the tourist industry in the West profitable. This is made all the more evident that throughout his career, Moran's various expeditions were almost invariably funded by railroad companies, who stood to gain the most from tourists interested in traveling West.<sup>33</sup> Watkins, in turn, was financially dependent upon sales of his prints to tourists.<sup>34</sup> Both Watkins and Moran are partially responsible for making the areas they photographed and painted, respectively, into national icons. Prior to the Hayden expedition and Moran's paintings, very little was known of the Yellowstone area. It was widely considered as a sulfurous hellhole.<sup>35</sup> It became a popular tourist destination shortly after the debut of Moran's paintings in the East. Watkins's photographs, especially those of the giant sequoias such as Grizzly Giant and of Yosemite, put the area on the map for tourists from the East.<sup>36</sup> More than simply depicting beautiful scenery, Moran and Watkins created lasting cultural icons of the areas they chose to depict.

The testament to the lasting impression of these artists works lies in far more than an increase in tourism to the areas they depicted, however. The artwork of both Moran and Watkins would become an essential part of convincing Congress to preserve the areas that were their chosen subject matter. Moran's sublime paintings together with the geological reports of Hayden and the lobbying of the railroads convinced Congress to preserve Yellowstone from further development in 1872.<sup>37</sup> Perhaps not coincidentally, The Grand Canyon of the Yellowstone became the first landscape painting to be purchased by the U.S. government that same year.<sup>38</sup> The photographs taken by Watkins that transformed Yosemite into a cultural icon were also passed around Congress in 1864 as part of the evidence used to garner support for the bill that made Yosemite inviolable.<sup>39</sup>

Moran's *The Grand Canon of the Yellowstone* and Watkin's *Grizzly Giant* sit at the intersection of major questions about perspective, documentation, enterprise, and preservation that were being asked in the late nineteenth century as the rapid pace of progress forced artists and the public to redefine what it meant to depict a landscape. By uniting science with the sublime, objective fact with subjective experience, and commercial endeavor with preservationist ethics, these pieces offer a view of the late nineteenth century in microcosm. They deal with questions about the struggle of artistic representation and the role it plays in shaping identity, enterprise, and culture – questions that have shaped visual culture in America and drastically changed the way in which we view the world around us and our place in it.

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<sup>31</sup> Ibid., 238-239.

<sup>32</sup> Ibid.

<sup>33</sup> Ibid., 247.

<sup>34</sup> "Carleton Watkins: Art and Perception," *National Gallery of Art*, accessed 14 December 2016, <http://www.nga.gov/exhibitions/watkinsbro.htm>.

<sup>35</sup> Kinsey, *Thomas Moran's West*, 60.

<sup>36</sup> Hutchinson, "They Might Be Giants," 121.

<sup>37</sup> "Art and the Hayden Geological Survey of 1871."

<sup>38</sup> Miller, *American Encounters*, 304.

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# Sexual Practice and Fantasy in Colonial America and the Early Republic

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**KEYWORDS:** colonial America, sexual practice, fantasy, colonial society

The modern academic study of sexuality has proven to be a potent tool for describing historical and political relationships between groups of people. “By historicizing matters once understood as universal and eternal, scholars of sexuality have connected sexual behaviors and desires to specific political, social, and economic contexts.”<sup>1</sup> Building upon this literature, I will argue that the ostensibly private realm of sex is inextricably intertwined with the racial, religious, and economic forces of a time period. The sexual practices of European colonists, Native Americans, and African-American slaves of the American colonies and early republic reflected economic and religious disparities, providing specific cultural phenomena upon which power relations were established and reaffirmed. These hierarchies not only prescribed the role of sex in quotidian American life; they created lasting traditions in sexual practices that continue to the present day.

For this thesis, I rely on contemporary and classic historiography, religious studies, and gender scholarship to make claims about the role of women in colonial society and the treatment and fantasy-construction of marginalized peoples: namely, African-American slaves and Native Americans. Specifically, I will show how colonial women leveraged their scarcity and sexual desirability to secure their gender’s procreative role and social utility in Puritan and Southern colonies. I will show how national myths of manifest destiny and the fecundity of the land came to dominate whites’ experience of Native American sexuality, how the formation and subjugation of the Black slave class acquired distinct and lasting sexual fault lines, and finally how political pressures and economic incentives to justify slavery nurtured whites’ sexual attitudes and behavior toward Blacks. I hope to synthesize these discussions with explorations of their role in shaping contemporary sex relations and the underlying ways these dimensions impacted everyday life in the American colonies and early Republic.

Colonial structures refracted and channeled sexual practice and fiction. As Michael Foucault reminds us, “Sexuality was ‘a result and an instrument of power’s design,’ a social construction of a historical moment (*The History of Sexuality*: 152). For Foucault, sexuality is not opposed to and subversive of power. On the contrary, sexuality is a ‘dense transfer point’ of power, charged with ‘instrumentality.’”<sup>2</sup> As Edward Said and Foucault remind us, knowledge production and behavior are products of political hierarchies and imperial legacy.<sup>3</sup> In this way, historical analysis of family politics, class divisions, and national myths provide important insights into the history of American sexuality.

Academic scholarship of colonial America has begun to provide a compelling alternative to H.L. Mencken’s stereotypical Puritan as tortured by the fear that “someone, somewhere, may be happy.”<sup>4</sup> Recent literature points to a diverse and complex system of sexual and family politics, giving support to the idea that “the once stark portrait of Massachusetts Bay as an austere religious community devoid of women’s authority and sexual diversity—or even of sexually active married individuals” is too simplistic an account.<sup>5</sup> The object of draconian sex laws was deviant practices, for which colonial society allocated a realistic possibility of repentance and reintegration. In contrast, the realm of the bedroom (or, the common room in early colonial structures) remained under the command of the married couple, who privately decided their sexual habits.

In contrast to previous assertions of Puritan life, individuals and sexual deviants could be reintegrated into colonial life and social standing if they successfully repented. In 1650, a young man Samuel Terry of Springfield, Massachusetts was found “chafing his yard to provoak lust” outside the church meetinghouse. The authorities lashed and fined him for public masturbation, but he broke the rules again by having premarital sex with his fiancé in 1661, and found himself again fined in 1673 for “immodest and beastly” activity with other

<sup>1</sup> Sharon Block and Kathleen M. Brown, “Clio in Search Eros: Redefining of Sexualities in Early America,” *William and Mary Quarterly* 60, no. 1 (2003): 6.

<sup>2</sup> Ann Laura Stoler, *Race and the Education of Desire: Foucault’s History of Sexuality and the Colonial Order of Things*. (Durham, North Carolina: Duke University Press, 1995), 3.

<sup>3</sup> Edward Said, *Culture and Imperialism*. (New York: Random House, 1993), 3–18.

<sup>4</sup> John Emilio and Estelle B. Freedman, Introduction to *Intimate Matters: A History of Sexuality in America*. (New York: Harper & Row, 1988).

<sup>5</sup> Sandra Slater, “Sex and Sin: The Historiography of Women, Gender, and Sexuality in Colonial Massachusetts,” *Historical Journal of Massachusetts* 41, no. 1 (2013): 105.

men.<sup>6</sup> By all classical characterizations of Puritan society, Terry would be an outcast and possibly incarcerated. Yet he defied the stereotype and lived on to serve as a town constable, respected by his fellows, and was even given custody by a town court over another man's infant.<sup>7</sup> Puritan society was lenient in this way, allowing someone who accepted punishment for his sins to continue as a respected citizen. To outcast him or exclude him from a productive capacity made him a burden to another breadwinner and posed an anomaly to the Puritan vision of the family. This is not to say laws were not draconian, but does suggest there were economic and social incentives for keeping such moral codes.

Men generally, in their role as breadwinners, profited from the procreative sexual norms of the day. Agricultural economies demanded children, illustrated in the New England laws against "solitary living."<sup>8</sup> These economies created stable societal units to ensure economic survival and provided the primary context in which youth were indoctrinated about how to view and limit sexual activity. The model of the family as the central economic unit necessarily problematized divorce, "idle" or single life, and children born out of wedlock. To prevent these issues, Puritan codes restricted sex to marital relations, incentivized women to stay in marriages, and minimized the ostracism of repentant individuals all to keep people within the family fold. "Colonies passed bastardy laws, patterned upon English antecedents, that severely punished the parents of bastards and attempted to hold the purported father responsible for the child's care."<sup>9</sup> Consequently, New England had lower bastardy rates compared to the Old South.<sup>10</sup>

High mortality rates made remarriage common and encouraged. Numbers of offspring were large. For example, John Winthrop, author of *City upon a Hill*, had sixteen children with four different wives. In the case of widows, the prospect of remarriage presented economic opportunities to colonial males. Unique "conduits of wealth and land, and with high mortality rates prevailing throughout the seventeenth century," colonial women were made objects of male competition, both as status symbols for the landed elite and as a means to land ownership for indentured servants in the south.<sup>11</sup> Agricultural labor demanded a steady supply of offspring, subject to strict supervision by society and family, lest they endanger their father's inheritance. To this end, Puritans delegated to parents the responsibility to "breed & bring up children & apprentices in some honest Lawfull

calling."<sup>12</sup> Children were expected to remain under their parent's supervision until marriage, and until that time they worked long hours. In these ways, puritan family structures were a far cry from the modern American nuclear family.

From this context, colonial women from New England areas used their capacity to rarify or scarify the resource of sex—by discouraging sex out of wedlock, before marriage, and out of pleasure—not simply out of religious compunction but for real economic incentive to augment the social value of their own motherhood and gender in a world dominated by male-oriented channels of accomplishment. This argument comes as a cross-application of Kristen Luker's *Abortion and the Politics of Motherhood* in which she demonstrates that contraception and abortion devalue the security of pro-life social location and resource availability; they collapse the sanctity of the private world of home and hearth in a loss that pro-choice women can afford because of their status in other realms. To pro-life women, and as I will argue for colonial-era women, an attitude that liberalizes sex undercuts access to worth. In their perceptions, liberal sexual attitudes limited women's ability to be married in the first place and undermined its procreative function within marriage.<sup>13</sup> Such a theory for sexual relations assumes the following:

1. Women were restricted from the same level of social and economic mobility that men had. Such is the case for Luker's pro-life, anti-abortionists whom she demonstrates to have dramatically lower levels of education and income while simultaneously high rates of children. Colonial women—who had virtually zero economic or social status outside of a family unit or marriage—can be counted in this category.
2. The primacy of the women's reproductive role is taken for granted and socially encouraged. Colonial women acknowledged the sacred value of motherhood, in accordance with Calvinist theology.
3. Anything to diminish or undermine the role of motherhood and married women as the exclusive sexual outlet diminishes the value of women married and aspiring to be. Women experience and respond positively to economic incentive to augment their own value as much as anyone else.
4. To relocate the purpose of sexuality as non-procreative and instead for amative intimacy and pleasure effectively downgrades the sacred place of the woman as mother and child-rearer. In addition, a sexual outlet

<sup>6</sup> Stephen Innes, *Labor in a New Land Economy and Society in Seventeenth-Century Springfield*. (Princeton: Princeton University Press, 2014), 132–133.

<sup>7</sup> Emilio and Freedman, *Intimate Matters*, 15.

<sup>8</sup> K. Kelly Weisberg, "Under Greet Temptations Heer' Women and Divorce in Puritan Massachusetts." *Feminist Studies*, 2 (1975): 183–193.

<sup>9</sup> Emilio and Freedman, 32.

<sup>10</sup> Ibid.

<sup>11</sup> Nancy Isenberg, *White Trash: The 400-Year Untold History of Class in America*. (New York: Random House, 2016). 37.

<sup>12</sup> Christopher L. Tomlins, *Freedom Bound. Law, Labor, and Civic Identity in Colonizing America, 1580–1815* (Cambridge: Cambridge University Press, 2010). 307–310.

<sup>13</sup> Kristin Luker, *Abortion and the Politics of Motherhood* (Berkeley: University of California Press, 1984), 158–215.

outside the religious parameters of marriage—such as masturbation, prostitution, or homosexuality—threatens the woman's social value in society.

5. Conversely, "Anything that supports a traditional division of labor into male and female worlds is in the interests of pro-life [colonial] women because that is where their resources lie."<sup>14</sup> To rarify the availability of sex augments its worth.

Therefore, we may predict societal pressures to limit sexual outlets outside of marriage, punish and shame offenders, and encourage women to have children as their productive function. Contemporary historiography accounts confirm these predictions. The procreative role did assume primacy: "Regional differences notwithstanding, by the early eighteenth century, sexual practice and sexual meaning were clearly situated within marriage, and the goal of sexuality was procreation."<sup>15</sup> As in the case of most preindustrial societies, "the family quickly became the central economic unit in every American colony," and "most women assumed that childbearing was their natural calling."<sup>16</sup>

Women did contribute to a culture of shaming lewd behavior. Neighbors "cursed women with epithets such as whore, adulteress, slut, or 'brassen-faced bawd.'"<sup>17</sup> In one instance, a Massachusetts woman spat a "slandorous comment at a couple, claiming that 'the wife was a whore and that shee had several children by other men, and that Cuckolday old Rogue her husband owned [acknowledged] them.'"<sup>18</sup> Even Nathaniel Hawthorne's novel *The Scarlet Letter* set in seventeenth-century Boston alludes to and employs public shaming of illegitimate or deviant sexual acts (such as adultery) as a central plot device. His audience took for granted shaming as a part of Puritan culture. As an archetypal example of female-to-female normativity policing, the mass hysteria of the Salem witch trials has sexual readings.<sup>19</sup>

Legal statutes permitted women to divorce their husbands if they failed to perform their conjugal duty whether by impotency or sloth, underscoring the centrality of the procreative bond and the legal encouragement of women's value as a reproductive channel. Women responded positively to this. In 1689, a Plymouth wife testified in court that "her husband was always unable to perform the act of generation," justifying her filed divorce. Contraceptive habits were grounds for divorce, "as in the case of Abigail Emery, who in 1710 complained that her husband practiced the 'abominable' sin of Onan (withdrawal) because 'he feared the charge of children.'"<sup>20</sup>

Such a success for women on policing and restricting access to sex in New England undoubtedly advanced prevailing religious morals of the time. Public church morality and revivalist rhetoric, such as from Cotton Mather and Thomas Shephard, warned against "inordinate affection" in the bedroom. Church courts had the authority to prescribe lashings, public stockings, and in some cases execution for such members of the community who violated laws against masturbation, premarital sex, and bestiality. Clergy were quick to emphasize the chastity of women and warn of the danger of "sensual lusts, wantonness and impurity, boldness and rudeness, in Look, Word or Gesture."<sup>21</sup> European Protestant thought, although contiguous to its American counterpart, did not go to such degrees. Settlers representing "civilization" compensated for the sodomized chaos they perceived around them "by creating excess of order, based on an ideal of extreme social cohesiveness and the practice of close surveillance of personal morality."<sup>22</sup> Membership to the privileged religious "Elect" was also guarded through sexually-transferred heritage. Under Reverend Increase Mather, the son of the famous preacher Cotton Mather, "God 'cast the line of Election' so that it passed 'through the loins of godly Parents.'...by celebrating lineage, the visible saints became a recognizable breed."<sup>23</sup>

In juxtaposition to the Massachusetts colony, the Chesapeake areas of Maryland and Virginia in the early to middle seventeenth-century provide another instance in which sexual circumstances were also used to increase social value. Southern colonies experienced a much higher sex ratio of indentured servants to women; during the first generations of Chesapeake settlement, male to female ratios were roughly 4:1 while their New England counterparts were a more even 3:2.<sup>24</sup> With the absence of New England-like family stability and a plentitude of male indentured servants,

the skewed ration in the Chesapeake delayed or prevented marital sexual relations, [and] pre- and extramarital sexuality seem to have been more common...Single women in the southern colonies were in such high demand as wives that they may have been less concerned about guarding their virginity than women in England or the Puritan settlements.<sup>25</sup>

Such an anomaly to the formula (family and motherhood = the seat of women's power) elaborates and confirms the original thesis. When women were allowed a means to develop valuation as sexual beings outside the parameters of

<sup>14</sup> Ibid., 200.

<sup>15</sup> Emilio and Freedman, 14.

<sup>16</sup> Ibid., 16, 25.

<sup>17</sup> Ibid., 17.

<sup>18</sup> Ibid., 18.

<sup>19</sup> See Tracy Fessenden, *The Puritan Origins of American Sex: Religion, Sexuality, and National Identity in American Literature* (New York: Routledge, 2001). And Robert Detweiler, "Shifting Perspectives on the Salem Witches," *The History Teacher* 8 (1975): 596–610.

<sup>20</sup> Emilio and Freedman, *Intimate Matters*, 26.

<sup>21</sup> Ibid., 18.

<sup>22</sup> Ibid., 9.

<sup>23</sup> Isenberg, *White Trash*, 34.

<sup>24</sup> Emilio and Freedman, *Intimate Matters*, 10.

<sup>25</sup> Ibid., 10–11.

procreative marriage—due to sheer male competition—sexual norms relaxed. Women could be less worried about preserving their virginity. Nuptial pregnancy rates—those children born in wedlock but conceived before it—were more than three times as high in the Chesapeake as in New England. Marriage rejections by females were higher than in the north. Sexual crime laws were more relaxed, and the dispersed nature of populations over farms and plantations made the threat of neighborly surveillance less of a salient fear to young couples.<sup>26</sup> “Knowing that they could easily remarry, Chesapeake-area women could be tempted by the advances of men other than their spouses, while husbands might well suspect that single men had designs upon their wives.”<sup>27</sup> The greater number of unattached men “meant that southern women had more opportunities for contact with single men,” and so women could pursue sex for romantic and erotic purposes.<sup>28</sup>

Women were also sought simply for their fertility. As England shipped off its “waste people” and “disposables” to work off their debts in the labor plantations of the American south, a unique white caste took hold, premised on their collective inability to produce heirs and secure access to land ownership. Women and children presented a way out of debt slavery. So much so, that writing in 1660 Maryland, former indentured servant George Alsop could claim bluntly that women fresh off the boats would “market their virginity” and sell “their breeding capacity of wealthy husbands.”<sup>29</sup> Perhaps most telling, during Bacon’s Rebellion of 1676 against Jamestown and its governor William Berkeley, “Bacon rounded up the wives of Berkeley supporters—his phalanx of ‘white aprons’—to guard his men while they dug trenches outside the fortified capital of Jamestown...They were too valuable a resource for either side to waste.”<sup>30</sup> In these ways, women developed sexuality as a mechanism to augment and promote their social value. Law and religion manifested the economic incentives of agricultural production, both for colonial women who sought to augment their social value as mothers and for southern women who had the chance to escape the restrictions of procreation and pursue a more amative discourse.

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Native American sexual practices and gender conceptions differed widely from European colonists and sometimes from one another. Westerners had difficulty relating such a gender status as the berdache or the practice of polygamy to their own binary and “civilized” conceptions, and this cognitive

dissonance facilitated the spread of militant evangelism and encouraged the impulse to ‘civilize’ or tame the native. The contrast between their sexual systems allowed Europeans to ignore “more similarities within their sexual systems than [they] cared to recognize,”<sup>31</sup> such as the rare use of contraception and the typicality of exclusive, heterosexual unions. European colonists capitalized on lascivious, alluring, and dangerous characterizations of American natives by framing expansionist policy as civilizing missions. To use Rudyard Kipling’s phrase, the “White Man’s Burden” became an unquestioned truism of the European and colonial ethic, supported by “the authorized monuments of nineteenth-century European culture, the inferiority of non-white races, the necessity that they be ruled by a superior race, and their absolute unchanging essence.”<sup>32</sup>

At the same time that “reports of Indian depredations and savagery...became a means of justifying white misbehavior and atrocities,”<sup>33</sup> Western accounts developed ambivalent, wistful attitudes toward what was seen as a fading Native culture. These Western narratives characterized the “good” Indians as “courteous, and hospitable to the initial invaders of his lands and to all Whites....Along with handsomeness of physique and physiognomy went great stamina and endurance...Modest in attitude...Brave in combat, he was tender in love for family and children.”<sup>34</sup> These strong, stoic representations were captured in the image of the Noble Savage and the Vanishing Native, as immortalized in the James Fenimore Cooper’s 1826 novel, *The Last of the Mohicans*, and embodied in the historical figure of Squanto.

Anthropologists have difficulty reconstructing reliable ethnographies of actual Native American sexual life due to a paucity of historical evidence, the sheer variety of native customs, and undocumented cultural destruction.<sup>35</sup> As well, Native American traditions were in flux over the 200 years between 1600 and 1800, in the same way European sexuality was, making it difficult to pinpoint specific continuities. However, in comparison to the white settlers, some generalities are well established.

“Most native peoples did not associate either nudity or sexuality with sin” in the same way European institutions and Christian theology suggested.<sup>36</sup> “Reproductive functions rarely evoked shame or guilt for Indian men or women. Many native American tribes accepted premarital intercourse, polygamy and institutionalized homosexuality” and even ascribed spiritual or shamanistic value to such encounters.<sup>37</sup>

<sup>26</sup> Mary Beth Norton, “Gender and Defamation in Seventeenth-Century Maryland.” *William and Mary Quarterly*, 43 (1987): 3–39.

<sup>27</sup> Emilio and Freedman, 10.

<sup>28</sup> *Ibid.*, 11.

<sup>29</sup> Isenberg, *White Trash*, 36.

<sup>30</sup> *Ibid.*, 39.

<sup>31</sup> Emilio and Freedman, *Intimate Matters*, 8.

<sup>32</sup> Edward Said, *Culture and Imperialism*, 151.

<sup>33</sup> Emilio and Freedman, *Intimate Matters*, 26.

<sup>34</sup> Joane Nagel, *Race, Ethnicity, and Sexuality: Intimate Intersections, Forbidden Frontiers* (New York: Oxford University Press, 2003), 75.

<sup>35</sup> Nagel, 72. See Davis, Jack L., and Robert F. Berkhofer. “The White Man’s Indian: Images of the American Indian from Columbus to the Present.” *American Indian Quarterly*, 28.

<sup>36</sup> Serena Nanda, *Gender Diversity: Crosscultural Variations* (Prospect Heights, Illinois: Waveland Press, 2000), 13.

<sup>37</sup> Emilio and Freedman, *Intimate Matters*, 7.

<sup>38</sup> *Ibid.*

The fluidity with which men could choose sexual partners also extended to women and youth. "Children grew up with few restrictions on sexual experimentation, which might range from masturbation to sexual play between same-sex or opposite-sex partners."<sup>38</sup> Such freedoms differed dramatically from the European colonists' experience, both indentured servants and New England Puritans; a white man found cheating on his wife could expect admonishments, possibly fines, or a night in the stocks. A woman of his standing could be flogged or divorced, effectively ending her economic viability.

The communitarian organization of native cultures facilitated a collective conception of family, allowing male and female members to explore extramarital and non-reproductive relationships with a degree of laxity not afforded to the Europeans. When a French Jesuit criticized such relationships on the grounds that a man could not determine "that his son was...his son," a Montagnais man (of upper Quebec) could say with assurance, "You French people love only your own children, but we all love all the members of our tribe."<sup>39</sup> Such a retort underscores the collectivist culture that allowed such sexual tolerance. These contrary cultural attitudes on sex and property precluded a great deal of sexual conflict. Marital discord was solved by "simply separating and forming new unions, without penalty, stigma, or property settlements."<sup>40</sup> Prostitution—with its assumptions of ownership and exchange—did not exist as an institution prior to its introduction by European settlers.<sup>41</sup> In contrast, the rigidity of Puritan formulas of marriage produced a remarkable similarity to sustained relationships of prostitution: a wife provided sex and children and in exchange, the husband provided a livelihood and social standing.

Even rape found little prevalence in cultures unaccustomed to the idea of "taking" someone's virginity or sexual integrity. Although "one of the few sexual acts forbidden by Indian cultures," rape did not quite occupy the same revered place in the listings of fears and brutalities as the Westerners had imagined.<sup>42</sup> "The Cherokee Nation, notably, only codified laws punishing rapists in the nineteenth century, after a period of close contact with white settlers."<sup>43</sup> Even English captive narratives, for which Mary Rowlandson's *The Sovereignty*

*and Goodness of God* is an emblem, described relief at the tolerance and graciousness of Indian captures: "By night and day, alone & in company, sleeping all sorts together, and yet not one of them ever offered me the least abuse of unchastity to me in word or action."<sup>44</sup> In contrast, European invaders saw rape and pillage as a right of war. It often precipitated white-native conflict, which presented an opportunity for whites to further evict, abuse, and control native tribes. Pushed by poverty, many Indian women chose to abandon their tribe for marriage with whites. These arrangements were often cruel and abusive. Indian trade in South Carolina as described by Theda Perdue was

replete with native complaints of sexual abuse. One trader "took a young Indian against her Will for his Wife," another severely beat three women including his pregnant wife whom he killed, and a third provided enough rum to a woman to get her drunk and then "used her ill."<sup>45</sup>

The study of mixed/multiple gender roles in Native American society occupies a distinctive prominence in anthropological scholarship.<sup>46</sup> When Europeans first encountered men in American Indian societies "who performed the work of women, dressed like women, and had sexual relations with men," (and to a lesser degree women who switched vice versa) they labeled them with the derogatory term "berdache" (derived from an Arabic word meaning male prostitute). The term misrepresented such individuals as homosexuals and hermaphrodites while in reality, these individuals operated outside the European vision of sexuality as binary.<sup>47</sup> Two-spirits (the non-pejorative term) had "partly or completely taken on aspects of the culturally defined role of the other sex and who are classified neither as women or men but as genders of their own."<sup>48</sup>

This third gender variant (in the case of women who chose male-dominated occupations and roles, a fourth gender) were not merely a marginal or deviant part. On the contrary, multiple sex/gender roles constituted "a normative part of American Indian sex/gender systems," premised on "occupational aspects...[not sexual preferences] as a central feature."<sup>49</sup> The presence of the male two-spirit has been documented in 110 to 150 societies in North America.

<sup>38</sup> Ibid.

<sup>39</sup> Eleanor Leacock, "Montagnais Women and the Jesuit Program for Colonization," in *Women and Colonization: Anthropological Perspectives*. Mona Etienne and Eleanor Leacock, eds., (New York: Praeger, 1980), 31.

<sup>40</sup> Emilio and Freedman, *Intimate Matters*, 8.

<sup>41</sup> Ibid.

<sup>42</sup> Ibid.

<sup>43</sup> Emilio and Freedman, 9. Also, James Axtell, *The Indian Peoples of Eastern America: A Documentary History of the Sexes* (New York: Oxford University Press, 1981), 70–71.

<sup>44</sup> Alden T. Vaughan and Edward W. Clark, *Puritans among the Indians: Accounts of Captivity and Redemption, 1676–1724* (Cambridge, Mass: Harvard University Press, 1981), 70.

<sup>45</sup> Nagel, *Race, Ethnicity and Sexuality*, 70. Also, see Theda Purdue, "Native Women in the Early Republic: Old World Perceptions, New World Realities," in *Native Americans and the Early Republic*, ed. Frederick E. Hoxie, Ronald Hoffman, and Peter J. (Charlottesville: University Press of Virginia, 1999), 96–97.

<sup>46</sup> See Sue Jacobs, *Two-spirit People: Native American Gender Identity, Sexuality, and Spirituality* (Urbana: University of Illinois Press, 1997); Sabine Lang, *Men as Women, Women as Men: Changing Gender in Native American Cultures* (Austin: University of Texas Press, 1998).

<sup>47</sup> Nanda, Serena. *Gender Diversity*, 11–12.

<sup>48</sup> Nanda, *Gender Diversity*, *ibid.* See Charles Callender and Lee M. Kochems, "The North American Berdache." *Current Anthropology* 24, (1983): 443–70.

<sup>49</sup> Nanda, *Gender Diversity*, 12, 15.

Considering the presence and exaggeration of the berdache in colonial literature from New England and the Chesapeake Bay, two-spirits most likely existed in the nations and tribes of the eastern seaboard as well before and during European settlement.<sup>50</sup> These individuals had the advantage of an “association between the spiritual power and gender,” and their often revered standing as warriors and their flexibility to take male and female sexual partners afforded gender variants a stature in Native American society unparalleled to modern attitudes toward gender non-conformists.

Perhaps unsurprisingly, Western encounters with native society that included two-spirits prompted moral outrage and misleading categorizations; Western anthropologists even into the 1970s had difficulty not romanticizing or misdefining the berdache in Western terms, “institutionalized homosexuality,” transsexuals or transvestites when the actual realities of sex/gender systems were more nuanced.<sup>51</sup> Gender differences aided “in the construction of an enduring ethnic boundary between Indians and non-Indians,” and the “sexualization of indigenous peoples...served the interests of colonial and American governments.”<sup>52</sup> The prevalence of captive stories, and symbolic prominence of figures such as Sacagawea reinforced a passive narrative of the indigenous as devoid of agency, a feature of the wilderness for which the American colonists were destined to conquer. However, “at the same moment, nonnatives were using imaginary native cultures and peoples to reinvent themselves as Americans” illustrated in way the white Sons of Liberty dressed as Mohawks in the 1773 Boston Tea Party and continuing to the peculiar place of Indian names (Braves, Red Skins) in American sport mascot tradition to this day.<sup>53</sup>

Among “some of the first popular publications written in the new world,”<sup>54</sup> captive narratives of nonnative women served to construct Native Americans as brutes worthy of conquering and subjugation. At the same time, they worked to preserve the sexual allure of the Other. These competing interpretations sent mixed messages to white women:

excitement, possible romantic bliss, but the chance of sexual harassment. The big, dark Indian was pictured simultaneously as a thrill and a sexual threat to white women and consequently a competitive sexual threat to white men.<sup>55</sup>

The memoirs of women such Caroline Harris, captured by Comanches in 1830 Texas, Mary Smith, captured in Kickapoos and Chickasaws in 1814, and Cooper’s *The Last of the Mohicans* solidified the image of Indians that “ravished, rifled, murdered and mutilated the inhabitants... without any

other provocation or incitement than brutal lust and wantonness of barbarity!”<sup>56</sup> In juxtaposition, native women were rarely described as ravished victims but as alluring nobility; the princess figure of Pocahontas stands in stark contrast to the tragic, hysterical character of someone like Jane McCrea.<sup>57</sup> Intermarriages acquired the same ethnosexual distinction: a white woman who joined with a Native man was a sexual threat and a loss of resources, while a native woman who joined a white man reaffirmed white inheritance of North America. Mixed-blood descendants “constituted a potential pool of ‘middlemen’ or cultural brokers between native communities...sometimes acted as ‘servants of power’ making deals with whites to the detriment of tribal relations.”<sup>58</sup>

Current historiography gives little evidence that European colonists adopted Native American sexual practices, though there were some notable exceptions. Thomas Morton established a Plymouth plantation in 1625 in radical opposition to Winthrop’s godly model of a City on a Hill.



*Death of Jane McCrea* by John Vanderlyn, 1804

<sup>50</sup> Callendar and Kochems, “The North American Berdache,” 444; Fulton, Robert, and Steven W. Anderson, “The Amerindian ‘Man-Woman’: Gender, Liminality, and Cultural Continuity.” *Current Anthropology* 33, (1992): 603–10.

<sup>51</sup> Nanda, *Gender Diversity*, 12.

<sup>52</sup> Nagel, *Race, Ethnicity, and Sexuality*, 81, 83.

<sup>53</sup> Ibid. Also, see Philip Joseph Deloria, *Playing Indian* (New Haven: Yale University Press, 1998).

<sup>54</sup> Nagel, *Race, Ethnicity, and Sexuality*, 72.

<sup>55</sup> June Namias, *White Captives: Gender and Ethnicity on the American Frontier* (Chapel Hill: University of North Carolina Press, 1993), 109.

<sup>56</sup> Kathryn Z. Stolada and James Levernier. *The Indian Captivity Narrative, 1550–1900* (New York: Twayne, 1997), 66.

<sup>57</sup> See Rebecca B. Faery, *Cartographies of Desire: Captivity, Race, and Sex in the Shaping of an American Nation* (Norman: University of Oklahoma Press, 1999).

<sup>58</sup> Nagel, *Race, Ethnicity, and Sexuality*, 77; Lewis A. Coser, “The Alien as a Servant of Power: Court Jews and Christian Renegades.” *American Sociological Review* 37, (1972): 574–581.

At the “Merry Mount,” Morton and his band of followers “engaged in ‘profane and dissolute living,’ including sexual relations outside of marriage.” He “revived the pagan May Day festivities, complete with the erotically charged maypole.”<sup>59</sup> Instead of expressing shock at native sexual habits, Morton invited them to join and had open sexual relationships. Merry Mount proved so threatening to the Pilgrim vision of social order and the Puritan family scheme that authorities tried unsuccessfully to deport him in 1628. When he returned to the Massachusetts Bay Colony, he was imprisoned and died soon after.<sup>60</sup>

Aside from the erotic appeal of pornography, Western fictions of the native brute as sexually promiscuous and violent offered “a convenient [and powerful] justification for warfare against native societies and for ‘removing’ Indians from areas chosen by whites for settlement.”<sup>61</sup> Captivity narratives rationalized massacres, eugenic campaigns, forceful assimilation strategies, and white responsibility for care-taking and the burdens of rule.<sup>62</sup> Even Sacagawea, the most enduring of Native American matriarchs and a national icon, symbolized a transactional purchase and sexual exchange from frontier wilderness to the West; she acted as both a willing guide to and object of, manifest destiny. The Lewis and Clark expedition recorded her as “purchased by Toussaint Charbonneau, a trader” and subsequently impregnated—a sanitized normalization of subjugated slavery and forced marriage.<sup>63</sup> Rebecca Faery interprets this ethnosexual exchange in her work *Cartographies of Desire* as a conflation of colonizers’ desires for land and their desire for

a Native woman who was a representative or stand-in for the land itself; likewise, the effort to ‘protect’ white women from the presumed desire of dark men, both Indian and African, was a coded insistence on the rights of the colonists to territory already taken or not yet taken but desired. The history of Anglo-America, then, is a map of confluent desires, sexual and territorial, that over time produced and consolidated the map of America as we know it today.<sup>64</sup>

In these ways, sex in colonial American and the Early Republic became a sociological site to define ethno-cultural boundaries between the Indian and European settlers, reify normative mentalities, and impose a hierarchy of power to justify expansionist and assimilationist aims of white settlers. Initially, as Kathleen Brown argues, “Indian women were much more likely to be described as beautiful and alluring by [early] English writers than were their African

counterparts.”<sup>65</sup> This focus shifted by the end of the 17<sup>th</sup> century, when African slaves became the dominant non-white population in and around the American colonies. While the trope of the predatory Indian has faded from modern literary iconography, the popular fiction of the black rapist and white victim remains a trope in novella. In addition, the dark, licentious “Jezebel” supplanted the Native American woman as the sexualized Other in American culture through the course of the 19<sup>th</sup> century, perhaps due to shifts in demography and social contact.<sup>66</sup> As subsequent Indian wars further marginalized tribes and neutralized their political threat to the expanding Republic, slaves expanded to fill the labor force. In the public imagination, Indians were on the frontier whereas Blacks were in their backyards and fields. It is no wonder that their fantasies shifted referents.

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As Puritan state regulation and disparate gender ratios faded in the course of colonial growth and immigration, “the sexual boundary between whites and black intensified.”<sup>67</sup> By the beginning of the 1700s, when white sex ratios in the colonies had converged, sexual distinctions had reorganized along racial lines, and the ethic of marital reproduction firmly taken root. The mass importation of African slaves after 1670 and the rise of Black chattel slavery with its accompanying interracial frictions produced the sharpest distinction between the sexual dynamics of the American South and New England, where plantation slavery simply did take hold. The formation of power hierarchies between slaves/indentured servants and their masters manifested in sexual controls—both in forced copulations, intermarriages, and sterilization procedures.

“The essence of Black women’s experience during slavery was the brutal denial of autonomy over reproduction. Female slaves were commercially valuable to their masters not only for their labor but also for their ability to produce more slaves.”<sup>68</sup> In addition, the ban on international slave trade in 1808 made domestic childbearing all the more valuable, as Thomas Jefferson suggested in 1820: “I consider a woman who brings a child every two years as more profitable than the best man on the farm.”<sup>69</sup> In this way, the sexual practices of breeding and rape assumed a strong economic incentive. Slave-owners often rewarded pregnancy with relief from work, additions in clothing and food, and manipulating slave marriage choices. The womb became an “article of commerce and slave children, ‘chattel’—movable property.”<sup>70</sup> Forced breeding, a controversial topic in anthropology of the

<sup>59</sup> Emilio and Freedman, *Intimate Matters*, 3.

<sup>60</sup> Emilio and Freedman, 3–4.

<sup>61</sup> Nagel, *Race, Ethnicity, and Sexuality*, 75.

<sup>62</sup> Sherry L. Smith, *The View from Officers’ Row: Army Perceptions of Western Indians* (Tucson: University of Arizona Press, 1990), 18.

<sup>63</sup> Nagel, *Race, Ethnicity, and Sexuality*, 75.

<sup>64</sup> Faery, *Cartographies of Desire*, 120.

<sup>65</sup> Kathleen Brown, “Native Americans and Early Modern Concepts of Race” in *Empire and Others: British Encounters with Indigenous Peoples, 1600–1850*, eds. Dauntton, Martin, and Rick Halpern. (Philadelphia: University of Pennsylvania Press, 1999), 91–92.

<sup>66</sup> Ibid.

<sup>67</sup> Emilio and Freedman, *Intimate Matters*, 38.

<sup>68</sup> Dorothy E. Roberts, *Killing the Black Body: Race, Reproduction, and the Meaning of Liberty* (New York: Pantheon Books, 1997), 24.

<sup>69</sup> Ibid., 25.

<sup>70</sup> Isenberg, *White Trash*, 41.

period, is established as a documented practice, alluded to in about 5 to 10 percent of slave narratives.<sup>71</sup> For males, similar procedures arose:

Slaveholders' interference with bonded men's intimate lives was often more than blunt. Some masters rented men of exceptional physical stature to serve as studs. Using terms such as "stockmen," "travelin' niggers," and "breedin' niggers," slave men remembered being weighed and tested, then used like animals to sire chattel for their masters.<sup>72</sup>

These inhuman practices did not develop overnight. The mass importation of African slaves to the American South began in the mid 17<sup>th</sup> century until African slaves threatened to attain a majority in Virginia and the Old South by the end of the century. The American colonists imported their English conceptions of blacks as "lewd, lascivious and wanton people" to rationalize the formation of a separate social caste. In such a way, sex became a mechanism to determine ethno-cultural boundaries and create white, American citizenship.

Legislation criminalizing black-white sexual interactions first emerged in the 1660s: Virginia doubled fines for interracial fornication in 1662 and criminalized interracial marriages in 1691, while Maryland adopted similar anti-miscegenation bans in 1664. Slavery codes included harsher punishments for interracial sexuality. However "unlike Spanish and Portuguese colonies, with their elaborate racial hierarchies in which mulatto children were often considered to be free rather than enslaved, the English colonies allowed no gradation of color."<sup>73</sup> Many local laws categorized race by the mother's line. South Carolina's code of 1696 and Virginia's in 1662 followed the Barbados slave code in stipulating, "All children borne in this country shall be held bond or free only according to the condition of the mother."<sup>74</sup> If she were black, the child was black, no matter the father's race. This convenient rule for white predators and slave owners meant that mixed-race slaves could fetch higher prices on the market and act as middleman to enforce white slave-owners' duties. However, sexual violence, as Roberts reminds us, did not have much of a direct economic function, since rape often had a debilitating effect on a slave's productive capacities and morale. Instead, she suggests rape was "primarily a weapon of terror...designed to stifle Black women's will to resist and remind them of their servile status."<sup>75</sup>

White males largely enforced anti-miscegenation laws only for their own women, as rape and sexual violence became another way for whites to reify dominance and control over blacks. While white women were forbidden from such interaction, "the enjoyment of a negro or mulatto woman was spoken of as quite a common thing"<sup>76</sup> among residents,

remarked a New England traveler during his visit to South Carolina. The ex-slave, African traveller Olaudah Equiano, in his writings to Western audiences, highlighted the disparity between sexual powers:

It was almost a constant practice with our clerks, and other whites, to commit violent depredations on the chastity of the female slaves...I have even known them to gratify their brutal passion with females not ten years old...And yet in Monserrat I have seen a Negro man staked to the ground, and cut most shockingly, and then his ears cut off bit by bit, because he had been connected with a white woman who was a common prostitute; as if it were no crime in the whites to rob an innocent girl of her virtue, but most heinous in a black man only to gratify a passion of nature, where the temptation was offered by one of a different color, though the most abandoned woman of her species."<sup>77</sup>

The double standard is well documented in legal records of the American colonies. Kathleen Brown's analysis on legal cases in colonial Virginia describe the impact of race:

"When a white woman accused a black man of rape, her chances of conviction appear to have been much higher. Of eighteen such cases to appear in Virginia's local and General Courts between 1670 and 1767, only two are known to have been dismissed. At least twelve of the nineteen accused black men were executed for their crimes."<sup>78</sup>

Although Virginia rape law ostensibly included all women, not a single recorded case of a white man prosecuted for the rape of a female slave was recorded in the entire 18<sup>th</sup>



*Rape of the Negro Girl* by Christiaan Van Couwenbergh, 1632

<sup>71</sup> Ibid., 25.

<sup>72</sup> Ibid., 28.

<sup>73</sup> Emilio and Freedman, *Intimate Matters*, 37.

<sup>74</sup> Betty Wood, *Origins of American Slavery: Freedom and Bondage in the English Colonies* (New York: Hill and Wang, 1997), 92.

<sup>75</sup> Roberts, *Killing the Black Body*, 30.

<sup>76</sup> Ibid., 36.

<sup>77</sup> Olaudah Equiano, *The Interesting Narrative of the Life of Olaudah Equiano, Written by Himself*, ed. Robert J. Allison (Boston: St. Martin's Press, 1995), 93–94.

<sup>78</sup> Kathleen M. Brown, *Good Wives, Nasty Wenches, and Anxious Patriarchs: Gender, Race, and Power in Colonial Virginia* (Chapel Hill: University of North Carolina Press, 1996), 209.

century.<sup>79</sup> Slaves had separate criminal courts and juries, lower standards of evidence, guilty until proven innocent burdens of proof, and harsher sentencing. “Nearly two-thirds of all sexual assaults prosecuted against black men ended with a death sentence. White men, however, were likely to receive a more diverse array of punishments: only slightly more than 10 percent of their prosecutions resulted in a death sentence.”<sup>80</sup> Capital punishment was disproportionately directed at black men: “Of the 174 men known to have been executed for criminal charges related to a rape between 1700 and 1820, 142—more than 80 percent—were identified as being of African descent” despite whites outnumbering blacks in every major American region (New England, mid-Atlantic, South).<sup>81</sup> Sharon’s sociological analysis concluded, “racial identities of both victims and defendants most strongly predicted the outcome of a sexual assault prosecution.”<sup>82</sup>

Colonial legislatures—such as in Pennsylvania, New Jersey, and Virginia—created the uniquely American criminal punishment of castration as a deterrence measure.<sup>83</sup> And while national penal codes gradually replaced capital punishment with incarceration after the American Revolution, these court systems systematically failed to include black men in those reforms. New England court systems, although officially unsegregated, still featured blacks as the overwhelming target in rape prosecutions. For example, “Connecticut’s nearly complete superior court records show that...Black men accounted for more than one-third of known Connecticut rape charges from 1700 to 1820, even though they never averaged more than 3 percent of Connecticut’s population.”<sup>84</sup> Prosecutions for black men accused of raping white women “remained surprisingly consistent in the colonial period and in the early Republic.”<sup>85</sup> White rapists would scapegoat their black peers. As women’s allegations were mistrusted, early Americans had a vested interest in concluding “that white women (practically the only legitimate victims in prosecuted rapes) would not voluntarily have sexual relations with black men, [so] black men were the most believable rapists of white women.”<sup>86</sup>

These court decisions taught colonists and early Americans to view black men as not only hypersexual, as their 17<sup>th</sup> century ancestors promoted, but as embodying innate proclivities to sexual aggression. This evolution of ideological production had humble beginnings: “In early America, there were virtually no known lynching and comparatively few polemical treatises on black hypersexuality of the kind that appeared by the end

of the nineteenth century.”<sup>87</sup> No evidence can be found that black men assaulted white women in slave uprisings during the colonial period,<sup>88</sup> and in general black men (the majority of slaves) had little ability to engage in sexual violence outside the parameters their masters ruled. However, the pressure to see blacks as vessels of evil and aggression justified the institution of slavery. Discrimination intensified after the American Revolution: repeated judicial confirmations of black men as singularly responsible, the widespread establishment of a plantation class, and the retreat of analogous threats to demonize (the Indians and the British) facilitated the rise of “widespread fear of black men’s hypersexuality,”<sup>89</sup> and the rhetorical power of rape focused on blacks with full force. In this way, the myth of the black aggressor became a positive feedback loop of ideology: simultaneously validated by rape prosecutions, while also fueling them. In this way, the myth of the black rapist has undergone several transformations according to the economic and political circumstance of reigning whites.

Constructions of black sexuality and aggression were central in producing the systematic bias of early American court systems. Western fantasies of Africa as the “heart of darkness” and home to brutes and lewd orgies has been an Orientalist tradition since Shakespeare, when the Othello’s portrait of the “lustful Moor” first popularized in England during the 1600s. Fascination with the Black’s male genitalia also proved continuous and remains a feature of American sex culture to this day. Richard Jobson, an explorer of African societies noted in 1623 that men were “furnished with such members as are after a sort of burthensome unto them.”<sup>90</sup> Fascination with the black penis continues, as exemplified in contemporary pornographic and erotica tropes.<sup>91</sup>

Despite the passage of much time and history since Europeans began settling North America and importing Africans to enslave for profit and profligacy, there remains in U.S. society today no ethnic boundary more sexualized or scrutinized than the color line dividing blacks and whites.<sup>92</sup>

As Dorothy Roberts details in *Killing the Black Body*, control of Black reproduction has remained an American tradition to the modern era. It includes the alliance of birth control activists and eugenicists in the 1920s and ’30s, government-sponsored sterilization procedures in the ’60s and ’70s, and the forced injection of Norplant and other contraceptives as requirements to receive welfare even into the ’90s.

<sup>79</sup> Roberts, *Killing the Black Body*, 31. Also, Sharon Block, *Rape and Sexual Power in Early America* (Chapel Hill: University of North Carolina Press, 2006), 182–193.

<sup>80</sup> Block, *Rape and Sexual Power in Early America*, 185.

<sup>81</sup> *Ibid.*, 99.

<sup>82</sup> *Ibid.*, 163–164.

<sup>83</sup> Emilio and Freedman, *Intimate Matters*, 36.

<sup>84</sup> Block, *Rape and Sexual Power*, 171.

<sup>85</sup> *Ibid.*, 167.

<sup>86</sup> *Ibid.*

<sup>87</sup> Block, *Rape and Sexual Power*, 166.

<sup>88</sup> Winthrop D. Jordan, *White over Black: American Attitudes toward the Negro, 1550–1812* (Chapel Hill: the University of North Carolina Press, 1968), 158, 398.

<sup>89</sup> *Ibid.*, 166.

<sup>90</sup> *Ibid.*, 33.

<sup>91</sup> Linda Williams, *Porn Studies* (Durham: Duke University Press, 2004), 185.

<sup>92</sup> Joane Nagel, *Race, Ethnicity, and Sexuality: Intimate Intersections, Forbidden Frontiers* (New York: Oxford University Press, 2003), 117.

The longevity of black rapist and white victim tropes in novella demonstrates the continued salience of these sexualized boundaries. While the image of the native woman has receded in popular reference as the sexualized Other, depictions of the dark Jezebel remain immediately recognizable in American culture. It is important to realize these fictions had political motivations and sexually reflected the dominance of the more powerful race. The creation of a strong, sexually competitive black male in Western discourse gave more gratification to see it vanquished. It also functioned to shock white women and possible deviators into racial conformity. To sexualize the African woman and deny her agency rationalized white supremacy; it was easier to sexually exploit people when they were seen as “always wanting it” or easily persuaded. Sex thus became a site to manifest the formation of racial hierarchies, formulate American citizenship, and enforce whites’ dominance. These hierarchies relied on violence for their endurance.

As Oscar Wilde observed, “Everything in the world is about sex except sex. Sex is about power.” Such an intersection is both striking and helpful for understanding the political narratives and practices of early American colonists and peoples. From this analysis, someone like Samuel Terry “chafing his yard to provoak lust,” the myth of the Black rapist, or the sale of Sacagawea can be contextualized in the political and social forces of the time period. I hope to have demonstrated that sexuality is a salient social platform on which historical power dynamics between groups are established and reaffirmed and that prevailing political and social forces of the time can explain its broader sexual dynamics. Specifically, I have demonstrated how colonial women leveraged their unique role as mothers and breeders to secure their access to worth in society, how sexuality informed and mapped class divisions and family relations between early American whites, how the fictions of native sexuality informed American myths of manifest destiny, and how rape and other sexual controls aided white supremacy and justified slavery. Finally, I showed how sex became a site to build racial hierarchies and formulate citizenship. The legacy of these boundaries still carries through to today. In this way, historical analysis of family politics, class divisions, and national myths provides important insights into the history of American sexuality.

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# “The Great Starlit Vault Of Heaven”: Walt Whitman’s Treatment of Death Through Astronomy

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## ABSTRACT

Death, or more accurately the defiance of death, is a recurring theme in Walt Whitman’s poetry. It is also an elusive one: though he consistently asserts humankind’s immortality, Whitman never arrives at a final treatment of death, instead allowing both his disposition toward death and the basis for his beliefs to be continually informed by his experiences. In this paper, I seek to better understand the metamorphosis of Whitman’s faith in immortality by exploring his use of astronomical imagery. He repeatedly calls upon stars, planets, and the night sky when discussing death, and his use of these motifs varies considerably throughout his career. To observe how the overlap between death and astronomy changes over time, I analyze poetry from three editions of *Leaves of Grass*: the first (1855), the edition published after the Civil War (1867), and the last (1891-1892). In doing so, I show that while Whitman initially found validation for immortality through external sublimity, this validation eventually collapses upon itself, leading him to discover an even more intense (yet still indefinite) proof within his own, internal poetic intuition.

**KEYWORDS:** Walt Whitman, *Leaves of Grass*, death, astronomy

## INTRODUCTION

“Great is life... and real and mystical... wherever and whoever, / Great is death ... Sure as life holds all parts together, death holds all parts together; / Sure as the stars return again after they merge in the light, death is great as life.” These are Walt Whitman’s parting words to the reader in the 1855 edition of *Leaves of Grass*, his first collection of poems published and later updated throughout his life. Whitman’s poetry has spanned generations and touched countless readers, including the painter of *The Starry Night*, Vincent van Gogh. In an 1888 letter to his sister—from which a quotation is used as the title of this paper—van Gogh describes his fascination with Whitman’s poetry.<sup>1</sup> Interestingly, it is suspected that this very fascination inspired van Gogh’s famous cosmic painting.<sup>2</sup>

To someone familiar with Whitman’s work, this might not be much of a surprise. Scattered throughout *Leaves of Grass* are images of stars, galaxies, “kosmos,” and the night. In particular, Whitman often uses astronomy to express his assured faith in immortality, at least in the first edition. As Whitman’s conviction becomes disfigured by post-Civil War disillusionment and later redeemed by old age, subsequent editions of *Leaves of Grass* offer a very different treatment of death through astronomy.

A concession: Whitman’s poetry is large, contains multitudes, and is at times contradictory.<sup>3</sup> It would be misguided to string a wholly unifying thread through its different editions, or even within a single edition, regarding a subject as expansive as death. Harold Aspiz, author of

*So Long! Walt Whitman’s Poetry of Death*, explains that Whitman “never develops an overarching or consistent theory of death.”<sup>4</sup> Like all humans, he was subjected to a “limited ability to grasp cosmic truths... thus the shifting strategies in the treatment of death.”<sup>5</sup>

Despite this ambiguity, I believe Whitman’s poetry contains an important connection between death and astronomy, one that has not yet been fully examined. In this paper, I seek to better understand Whitman’s evolving faith in immortality by exploring the connections between the changing treatment of astronomy in his work and his representation of death. I begin with the first edition of *Leaves of Grass*, proceed to the edition published after the Civil War, and end with the “deathbed” edition. By comparing the shifts in his use of astronomical imagery over the course of time, I illustrate how Whitman’s initial belief in immortality is transformed by his encounters with the deaths of his fellow Americans and, eventually, the imminence of his own departure.

## AUTHORITY AND DUALITY IN THE FIRST EDITION

Whitman was thirty-five years old when he published the first edition of *Leaves of Grass* in 1855.<sup>6</sup> In it, he envisions a new American philosophy, one that affirms both the grandeur and persistence of the human spirit. His philosophy was informed by a number of influences: his Quaker upbringing; his father’s bold, democratic principles;

<sup>1</sup> Vincent van Gogh, *The Complete Letters of Vincent Van Gogh, Volume Three* (Boston: New York Graphic Society, 1981): 445.

<sup>2</sup> Jean Schwind, “Van Gogh’s ‘Starry Night’ and Whitman: A Study in Source,” *Walt Whitman Quarterly Review* 3 (1985): 1-15.

<sup>3</sup> According to Whitman himself: “Do I contradict myself? / Very well then... I contradict myself; I am large... I contain multitudes” (Whitman 2007, 67).

<sup>4</sup> Harold Aspiz, *So Long!: Walt Whitman’s Poetry of Death* (Tuscaloosa: University of Alabama, 2004), 3-4.

<sup>5</sup> *Ibid.*, 3-4.

<sup>6</sup> John Townsend Trowbridge, “Reminiscences of Walt Whitman,” *The Atlantic Monthly* (February, 1902): 163-75.

scientific knowledge; Eastern mysticism; and, most importantly, Ralph Waldo Emerson's Transcendentalist essays.<sup>7</sup> In particular, Emerson's idea of the Over-Soul, a single, spiritual entity through which humans are interconnected, provides the backbone for Whitman's understanding of a spiritual immortality.

More remarkable than the eclecticism of these influences is the fact that none are directly credited in *Leaves of Grass*. There are only allusions or reflections of these influences in the poetry's style and message. Though he drew from numerous sources, Whitman sought to present his own, singular vision of America, one without a basis in past institutions.<sup>8</sup> He renounces blind conformity to institutional authority, instead encouraging the reader to "transcend" society and seek out the truth themselves. His vision was also distinguished from those of other Transcendentalists by an emphasis on earthliness, a "passion for his native soil" in both the national and physical sense.<sup>9</sup> *Leaves of Grass* is so self-contained that some scholars have gone as far as claiming its poems are "parts of a coherent religious myth."<sup>10</sup>

Whether or not this is true, two important questions arise. The first: How does Whitman manage to convince the reader of his radical ideas on immortality without the authority of a spiritual institution (or empirical evidence) at his disposal? The second: How does Whitman reconcile earthliness with the overarching grandeur of his poetry, particularly his understanding of spiritual immortality? The answers to both lie in his repeated use of astronomical imagery.

In one way, the authority of astronomical bodies is derived from their mysteriousness and sublimity. Whitman equates immortality to a planet's orbit, saying "To me the converging objects of the universe perpetually flow, / ... And I know I am deathless. / I know this orbit of mine cannot be swept by a carpenter's compass."<sup>11</sup> Planets are too distant and too large to be fully comprehended by humankind; similarly, we are unable to completely grasp the nature of our deathlessness. Through this metaphor, Whitman not only asserts humankind's immortality, but also justifies his omission of an "overarching or consistent theory of death" by pointing out the impossibility of such an undertaking. He expands upon this metaphor in another passage as well:

"I open my scuttle at night and see the far-sprinkled systems,  
And all I see, multiplied as high as I can cipher, edge but the rim

of the farther systems.

Wider and wider they spread, expanding and always expanding,  
Outward and outward and forever outward.

My sun has his sun, and round him obediently wheels,  
He joins with his partners a group of superior circuit, [...]  
There is no stoppage, and never can be stoppage; [...]  
I tramp a perpetual journey,<sup>12</sup>

While it is interesting to note Whitman's description of an expanding universe predates its 1929 scientific discovery by Edwin Hubble,<sup>13</sup> *Leaves of Grass* was written well after the acceptance of Kepler's and Newton's mechanical laws,<sup>14</sup> so his audience would have understood the connection between the continuity of planetary motion and humankind's immortality. Moreover, their reliance on accepted scientific knowledge for visualizing the astronomical imagery, instead of their own immediate observation, parallels the leap of faith necessary for accepting Whitman's claim of immortality. He challenges his readers: "Did you guess the celestial laws are yet to be worked over and rectified?"<sup>15</sup> Here, "celestial" takes on a dual meaning, referring to both the spiritual and the astronomical. Readers must trust the poet's authority to describe spiritual truth as they trust the physicist's authority to describe astronomical truth.

A second way astronomical imagery creates authority is through close interactions with religion. Specifically, Whitman extracts authority from religious institutions by placing religious allusion alongside astronomical imagery. One example is this passage featuring references to the realms of afterlife from Christian and Ancient Greek traditions:

My feet strike an apex of the apices of the stairs, [...]  
All below duly traveled—and still I mount and mount.

Rise after rise bow the phantoms behind me, [...]  
Cycles ferried my cradle, rowing and rowing like cheerful  
boatmen;  
For room to me stars kept aside in their own rings,  
They sent influences to look after what was to hold me.<sup>16</sup>

Whitman merges the Christian "stairway to heaven" with imagery reminiscent of Charon, the boatman of the Greek underworld. These religious undertones are followed by "stars kept aside in their own rings," causing the authority of religion to diffuse into the astronomical imagery. Whitman can then pursue this connotation throughout

<sup>7</sup>Trowbridge, "Reminiscences of Walt Whitman," 163-75; Larry J Reynolds, *European Revolutions and the American Literary Renaissance* (New Haven: Yale University Press, 1988), 126; Joseph Beaver, *Walt Whitman, Poet of Science* (New York: King's Crown Press, 1951); Nathaniel Preston, "Walt Whitman's Use of Indian Sources: A Reconsideration," *The Ritsumeikan Bungaku* 627 (2012): 4.

<sup>8</sup>Preston, "Walt Whitman's Use of Indian Sources: A Reconsideration," 1.

<sup>9</sup>Larry J Reynolds and Tibbie E. Lynch, "Sense and Transcendence in Emerson, Thoreau, and Whitman," *The South Central Bulletin* 39, no. 4 (1979): 148; Walt Whitman, *Leaves of Grass: The Original 1855 Edition* (Mineola: Dover Publications, 2007): v.

<sup>10</sup>David Kuebrich, *Minor Prophecy: Walt Whitman's New American Religion* (Bloomington: Indiana University Press, 1989): 4.

<sup>11</sup>Whitman, *Leaves of Grass*, 35.

<sup>12</sup>*Ibid.*, 62-63.

<sup>13</sup>Edwin Hubble, "A Relation between Distance and Radial Velocity among Extra-Galactic Nebulae," *Proceedings of the National Academy of Sciences of the United States of America* 15, no. 3 (1929): 168-73.

<sup>14</sup>Gerald James Holton, and Stephen G. Brush, *Physics, the Human Adventure: From Copernicus to Einstein and beyond* (New Brunswick: Rutgers University Press, 2001): 40-46, 131-136.

<sup>15</sup>Whitman, *Leaves of Grass*, 37.

<sup>16</sup>*Ibid.*, 61.

his text, lending authority to the surrounding stanzas without referencing religion at all. This is exemplified in his self-declaration “Walt Whitman, an American, one of the roughs, a kosmos.”<sup>17</sup> He goes on to describe himself in a coarse, earthly fashion that would have turned most readers away if not counterpointed by his use of the single word “kosmos.” Along with being a scientific reference to Humboldt’s encyclopedic book,<sup>18</sup> “kosmos,” without being itself a religious allusion, surrounds Whitman with an aura of quasi-religious power. Through astronomy, Whitman gains credibility without becoming an institution, relating back to his desire to present a singular vision.

Whitman’s self-characterization as a “kosmos” is also an example of a separate phenomenon in Whitman’s poetry: the intertwining of natural and astronomical imagery in order to describe the dual nature of immortality. Whitman uses natural imagery, often in the form of plant life, to represent physical immortality. He sees grass as “the beautiful uncut hair of graves,”<sup>19</sup> “the smallest sprout” as an indication of immortality,<sup>20</sup> a corpse as “good manure,”<sup>21</sup> and the grave of a dead soldier as growing “seed for freedom... in its turn to bear seed.”<sup>22</sup> By relating death to these modest symbols of life, he depicts physical rebirth as benign and universal. Whitman then contrasts physical immortality with spiritual immortality by the direct juxtaposition of natural and astronomical imagery. He hears voices “of the threads that connect the stars—and of wombs, and of the fatherstuff,” concluding that “copulation is no more rank to me than death is.”<sup>23</sup> He senses the “generations” guiding his “embryo,” for which “the nebula cohered to an orb.”<sup>24</sup> Finally, he listens to the whispering of “O stars of heaven, / O suns... O grass of graves... O perpetual transfers and promotions.”<sup>25</sup> Each of the preceding examples have astronomical imagery entangled with the natural: stars, wombs, and “fatherstuff”; an embryo and a nebula; stars of heaven and grass of graves. What stands out is the difference in familiarity. The natural imagery relates to observations the reader can find in his or her backyard; the astronomical imagery is unreachable and unfathomable. Suzan Setzer singles out the line, “I believe a leaf of grass is no less than the journey-work of the stars,”<sup>26</sup> commenting that readers must feel “how the one is an expression of the other, thus taking in the entire process of creation in one sentence.”<sup>27</sup> Through all these pairings, Whitman is saying

that spiritual immortality should be as immediately obvious as the physical immortality apparent in nature. The dead remain connected to the living, in the form of the manure that nourishes the sprout and as the threads which connect the stars, our guiding ancestors.

In the first edition of *Leaves of Grass*, Whitman crafts a character of himself who is all-encompassing, at once looking down from the heavens, through the eyes of the American people, and up between the leaves of grass at their feet. His poetry constructs these parts as a whole, an infinite procession “with measured and beautiful motion.”<sup>28</sup> Through astronomical imagery, Whitman is able to transcend limitations of time and space, to exist among the immortal planets and stars.

## THE AFTERMATH OF THE CIVIL WAR

Whitman’s affirmation of immortality, expressed with confidence in the first edition, becomes remarkably more conservative in his poetry following the Civil War. As a volunteer nurse, he was a direct witness to the Civil War’s carnage, an experience that led him to question the extent to which a poetic belief in immortality comforted the loss of human life.<sup>29</sup> The changes in his perception of death are evident in two poems first added to *Leaves of Grass* in the 1867 edition: “When Lilacs Last in the Dooryard Bloom’d,” an elegy for the assassinated President Lincoln, and “Vigil Strange I Kept on the Field One Night.”<sup>30</sup> In both of these poems, the poet remains grounded by his earthly existence, looking up into a night sky unreflective of human grief and impermanence.

Central to “Lilacs” is a trio of images: lilac, bird, and star. While Whitman’s previous poetry depicts astronomical bodies as vast and untouchable, the star in “Lilacs,” used to personify Lincoln, is much different. Though “great” and “powerful,” it “early droop’d in the western sky” and is hidden by a “black murk.”<sup>31 32</sup> The star closely interacts with him, wandering by his side until it is “lost in the netherward black of the night” and detaining him – in other words, lingering in his thoughts.<sup>33</sup> In contrast, the other stars continue their cyclical procession uninhibited.

The singularity of Lincoln’s star in “Lilacs” reflects the poet’s confinement within himself. Whitman no longer speaks with an all-encompassing voice, and is instead encompassed himself by the spirit of death. Just as the star is separated

<sup>17</sup> Ibid., 38.

<sup>18</sup> Alexander von Humboldt, *Kosmos* (Stuttgart, Germany: Cotta, 1845).

<sup>19</sup> Whitman, *Leaves of Grass*, 24.

<sup>20</sup> Ibid., 25.

<sup>21</sup> Ibid., 66.

<sup>22</sup> Ibid., 104.

<sup>23</sup> Ibid., 39.

<sup>24</sup> Ibid., 62.

<sup>25</sup> Ibid., 66.

<sup>26</sup> Setzer, “Whitman, Transcendentalism, and the American Dream,” 41.

<sup>27</sup> Ibid., 32.

<sup>28</sup> Whitman, *Leaves of Grass*, 95.

<sup>29</sup> Aspiz, *So Long!*, 161.

<sup>30</sup> Walt Whitman, *Leaves of Grass*, 4th ed. (New York: Wm. E. Chapin & Co., 1867): xl-xli, xvii.

<sup>31</sup> The 1867 edition of *Leaves of Grass* consists of four parts, each with their own page numbering: *Leaves of Grass*, *Drum Taps*, *Sequel to Drum Taps*, and *Songs Before Parting*. To avoid confusion, I appended “a,” “b,” and “c” to page number citations for *Drum Taps*, *Sequel to Drum Taps*, and *Songs Before Parting*, respectively.

<sup>32</sup> Ibid., 3b.

<sup>33</sup> Ibid., 6b.

from the greater universe by a “black murk,” Whitman’s soul is made “helpless” by “cruel hands” and a “harsh surrounding cloud”; the Earth is enveloped by the “coming eve.”<sup>34</sup> This does not mean Whitman retracts his claims for immortality; at the end of the poem, night becomes day and the poet leaves the lilac untouched, “blooming, returning with spring.”<sup>35</sup> He also does not condemn death, instead beckoning it to “undulate round the world, serenely arriving, arriving.”<sup>36</sup> What is different is that he speaks from a personal, rather than global, perspective. Unable to see past the horizon, Whitman no longer places death within the context of a greater, infinite procession.

The disconnection between astronomical movement and human life is also apparent in “Vigil Strange I Kept on the Field One Night.”<sup>37</sup> In this poem, the poet returns to a fallen comrade to discover he has died. The dead boy has “bared [his] face in the starlight,” his still face unreflective of the rotating heavens he looks upon. During the poet’s vigil, “as onward silently stars aloft, eastward new ones upward stole.” As in “Lilacs,” the stars continue their procession indifferently, and while the poet recognizes the “sweet hours, immortal and mystic hours” spent with his comrade, he nonetheless is left in grief.

In the first edition of *Leaves of Grass*, Whitman uses astronomy to create authority and to illustrate the duality of body and soul. In “Lilacs” and “Vigil,” authority instead comes from the authenticity of the poet’s own grief. Moreover, though Whitman still intertwines the natural with the astronomical, he severs the connection between life and death for both. In “Lilacs,” he does not follow up on the metaphor of Lincoln’s star to comment on how the star will rejoin the others, thus returning the next night. Similarly, the vibrant, natural imagery of a “gorgeous, indolent, sinking sun,” “fresh sweet herbage,” and the “breast of the river” only contrast with the soldiers who lie dead on the battlefield.<sup>38</sup> Whitman is silent about their return to the natural world. The living and dead occupy different spheres, both spiritually and physically.

## WHITMAN’S PARTING THOUGHTS

Whitman went on to live for more than twenty years after the Civil War. This left time for him to accept the losses of the war, and time to come to terms with his own ailing health. He

never ceased writing, publishing the final, enormous edition of *Leaves of Grass* (the “deathbed” edition) in 1892, the same year of his death. I chose two pairs of poems from this final edition to analyze based on their dialectical relationships. “On the Beach at Night Alone” and “On the Beach at Night” are intended to be read together, evidenced by their similar titles, similar content, and Whitman’s placement of them close to each other.<sup>39</sup> “Alone” was first published in 1856 under the title “Clef Poem,” and “Night” in 1871.<sup>40</sup> “Grand is the Seen” and “Unseen Buds” constitute the other pair; they were both first published in 1891 and placed adjacently toward the end.<sup>41</sup> In temporal order, these poems seem to summarize Whitman’s evolving relationship with death.

Much like poetry from the first edition, “On the Beach at Night Alone” presents an all-encompassing, almost simplistic view of immortality. The poet refers to a “vast similitude [that] interlocks all,” one that “shall forever span them and compactly hold and enclose them.”<sup>42</sup> He uses astronomy to create a sense of authority, universality, and sublimity. In this way, “On the Beach at Night” readily serves as its foil. Here, the poet is now with a child, and is soothing her fear of the black clouds covering the stars. He tells her that the stars shall soon emerge, and that they are “immortal”; however, he does not seem to be honest, as he later ponders the burial of the “delicate” Pleiades.<sup>43</sup> This is surprising: Whitman’s earlier poetry connected astronomical cycles to human immortality. His postwar poetry questioned the extent of that connection. Now, Whitman claims that the stars themselves are fallible. Instead, he sees something in humans “more immortal even than the stars.”<sup>44</sup> But what?

At first thought, the answer might be the human soul. That is certainly Whitman’s reply in “Grand is the Seen”: “Grand is the earth, and grand are lasting time and space, / ... But grander far the unseen soul of me, comprehending, endowing all of those / ... More multiform far—more lasting thou than they.”<sup>45</sup> However, this is clearly not his full response; the poem immediately following, “Unseen Buds,” is a pivotal addendum. Whitman describes “unseen buds, infinite, hidden well, / ... Like babes in wombs... (On earth and in the sea—the universe—the stars there in the heavens,) / Urging slowly, surely forward, forming endless, / And waiting ever more, forever more behind.”<sup>46</sup> By transforming bud to star, he places the

<sup>34</sup> Ibid., 38.

<sup>35</sup> Alexander von Humboldt, *Kosmos* (Stuttgart, Germany: Cotta, 1845).

<sup>36</sup> Whitman, *Leaves of Grass*, 24.

<sup>37</sup> Ibid., 25.

<sup>38</sup> Ibid., 66.

<sup>39</sup> A. James Wohlpert, “From the Material to the Spiritual in the Sea-Drift Cluster: Transcendence in ‘On the Beach at Night,’ ‘The World below the Brine,’ and ‘On the Beach at Night Alone,’” *Walt Whitman Quarterly Review* 13 (1996): 150.

<sup>40</sup> Walt Whitman, *Leaves of Grass: A Textual Variorum of the Printed Poems*, 3 vols, ed. Sculley Bradley (New York: New York University Press, 1980): xxxvi, xlii, 241.

<sup>41</sup> Ibid., xlv.

<sup>42</sup> Walt Whitman, *Leaves of Grass* 9th ed. (Philadelphia: David McKay, 1891-1892): 207.

<sup>43</sup> Ibid., 206.

<sup>44</sup> Ibid.

<sup>45</sup> Ibid., 421.

<sup>46</sup> Ibid.

procreant and “unseen” force of immortality into the heavens. Immortality becomes an Over-Soul-like entity, too complex and universal to be delineated to the human soul. Perhaps this is the final function of astronomy in Whitman’s work. As the last frontier for humankind, it is the keeping place for our greatest secret. For Whitman, recognizing the safe-keeping of human immortality is enough; he does not feel the need to uncover it and reveal its contents.

## CONCLUSION

A look at the skies has been traditionally associated with thoughts of eternity or even death, and Whitman’s use of astronomical imagery is no exception. Like many humans before him, he sought to thread the vast array of lights in the heavens into meaningful constellations. In his earlier work, he appeared to do so by transcending mortal limitations through astronomical imagery. Later, he instead used astronomy to enhance the elusive shroud of death. While Whitman may have initially held claim to a universal proof for immortality, I believe during the final years of his life he arrived at a more personal understanding of immortality. The “proof” became his own poetry in and of itself, a domain that extends past Earth and sky, encompassing even astronomical bodies and, with them, the mystery of human immortality.

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An abstract sculpture of a human face, carved into a light-colored, textured material like sand or clay. The face is shown in profile, looking towards the right. The features are soft and rounded, with a prominent nose and a slight smile. The lighting is warm and directional, coming from the upper right, which creates deep shadows in the recessed areas of the face and highlights the texture of the material. The overall composition is minimalist and focuses on the form and texture of the sculpture.

# Social Sciences



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# A proposed EEG study: the role of object affordance during action observation

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## ABSTRACT

Over the past two decades, research on the human mirror neuron system (MNS) has flourished. According to this model, there is substantial evidence that both action execution and action observation activate the motor system. However, to date, few studies have attempted to examine the role that object affordance may have during action observation. The proposed study attempts to assess this and other issues by having participants watch videos of an actor making goal-directed reaches to a common household object. In the congruent condition, the actor makes a reach and grasps the handle of a mug. In the affordance incongruent condition, the actor makes a reach but grasps the side of the mug opposite from the handle. Electroencephalogram (EEG) will be recorded throughout participant viewing and the EEG data will be decomposed into frequency bands using a Morlet wavelet analysis. The mu rhythm (8-13 Hz) will be of particular interest. Electrode sites of interest include sites over the central parietal areas as well as frontal sites. It is hoped that the proposed study will provide insight into the role of object affordance during action observation.

**KEYWORDS:** Action Observation, Object Affordance, Mirror Neuron System, Mu Rhythm

## INTRODUCTION

Evidence suggests that similar patterns of brain activation occur during both action execution and action observation. This model, often known as the mirror neuron system (MNS), is supported by evidence from studies done in macaque monkeys (Di Pellegrino et al. 1992, Rizzoliti et al. 1996), behavioral studies (Brass, Bekkering, Wohlschläger, & Prinz 2000, Bertenthal, Longo, & Kosobud 2006, Longo, Kosobud, & Bertenthal 2008, Gillmeister et al. 2008, Boyer & Bertenthal 2013) and studies done using fMRI (Buccino et al. 2001, Grèze, Armony, Rowe, & Passingham 2003). It is thought that the mirror neuron system helps us to identify the intentions of others (Iacoboni et al. 2005) and may facilitate empathy (Iacoboni 2009).

Recent research indicates that event related desynchronization of the mu rhythm (8-13 Hz) may reflect activation of the mirror neuron system. For instance, Muthukumaraswamy, Johnson, and McNair (2004) observed that participants showed mu suppression when viewing a grasp of a manipulandum but not when viewing a similar, empty grasp. In a different study, Perry and Bentin (2009) detected mu desynchronization when participants viewed reaches but not when participants viewed other movements.

Not only has been mu desynchronization been observed during action observation, but also when viewing tools and objects. For instance, Proverbio (2012) had participants view objects with a congruent grasp as well as non-objects and objects with an incongruent grasp. Participants showed significantly more mu suppression when viewing objects with congruent grasps than during the other conditions. In a similar, behavioral study, Bach, Bayliss, and Tipper (2010) had participants move a joystick to the left or right while watching an actor make grasps that were either congruent or incongruent with the affordance of an object. Importantly, the compatibility effects were only found when participants

viewed grasps that were congruent with the affordance. These findings suggests that the perception of objects may be important for motor activation during action observation.

When we observe someone performing a goal-directed action, we pay attention to not only the individual, but also the object that they are interacting with. In his theory of object affordance, Gibson (1979) proposed that the properties of certain objects naturally allow us to act on them. For instance, we typically pick up a mug using the handle rather than using the top or the side opposite from the handle. The handle affords a grasping motion allowing us to easily pick up the mug.

Relatively few studies have attempted to dissociate the roles that object affordance might play in action observation. Recently, Bach, Nicholson, and Hudson (2014) proposed the affordance-matching hypothesis. According to this model, individuals automatically retrieve information about the objects around themselves as well as the objects around others. This model suggests that understanding the properties of objects and the ways that they can be manipulated are essential during action observation. Thus, the purpose of the current is to assess this relationship between object affordance and action observation by measuring event related desynchronization of the mu rhythm.

## PROPOSED METHODS

### Participants

We hope to test approximately 30 participants all of whom will be right-handed with normal or corrected-to-normal vision. They will be recruited from a large, public university and will receive course credit for participation in the study.

### Design

The stimuli consists of eight reach videos. In the videos, an actor sits behind a table in the center of the screen. A

red mug with a handle is seen on either the left or the right side of the table, depending on the condition. All reaches are right handed only and both ipsilateral and contralateral reaches are done. In the congruent condition, the actor reaches for the handle of the cup. In the incongruent condition, the actor reaches for the side of the cup opposite of the handle. These same 4 conditions are also done with an inverted cup. Examples from each condition can be found in figure 1. To ensure the best possible viewing conditions, the contrast of the stimuli was adjusted in Adobe Premiere Pro. Additionally, Adobe Premier Pro was used to ensure that all reaches had the same number of frames. One to three frames were systematically removed. All reaches lasted 1.2 seconds.

Stimuli will be presented using EPRIME 2.0. Participants will sit 70 inches away from a 17" computer monitor. Each trial will consist of a fixation cross for 500 ms and one reach which will be paused after the completion of the reach. The still frame of the reach will remain on the screen for 1000 ms and the intertrial interval (ITI) will be 1000 ms. The study will be divided into 8 blocks which will last approximately 5 minutes. In each block, participants will see 48 trials where each of the eight conditions are presented six times per block. Thus, participants will view a total of 384 trials which are pseudorandomized within the blocks. Continuous EEG data will be collected throughout the duration of the stimulus presentation.

### Procedure

Participants will be instructed to avoid excessive movements and to blink during the ITI when possible. There will be 3 probe trials per block of 48 that are interspersed randomly. Participants will be instructed to press the space bar when a white cross appears on the cup. These probe trials are used to ensure participants pay attention throughout the task. EEG data for the probe trials will not be analyzed.

### EEG Recording, Preprocessing, and Analysis

Participants will wear the Hydrocel geodesics sensor net which contains 64 active Ag/AgCl electrodes. Data will be amplified using EGI Net Amp 300 and will be sampled at 1000 Hz. Electro-oculogram (EOG) will also be recorded in order to detect eye movements. Impedance measures below 50 k $\Omega$  are considered acceptable.

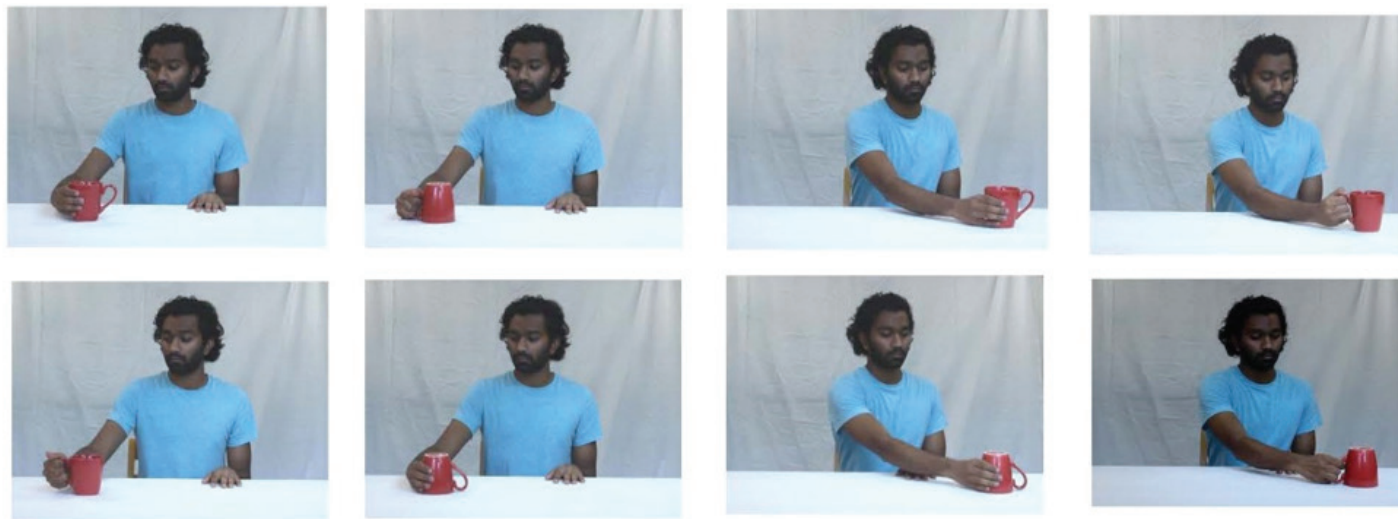
Data will be processed using the EEGLAB toolbox in Matlab. The continuous data will be band-passed filtered between 0.1 and 100 Hz. If 60 Hz line noise is present, the function cleanline will be used to remove this noise. The data will be epoched into 3.2 second epochs. The epoched data will be visually inspected for bad channels and gross muscle artifacts which will be removed. Participants will not be used in the final sample if more than 33% of their total trials have to be removed. Independent component analysis (ICA) will be run and components that constitute eye blinks, eye movements, or EMG will be removed. Data will be re-referenced offline to the average of all scalp electrodes. Any bad channels that had been removed previously will be interpolated. After pre-processing, data will be analyzed using the EEGLAB toolbox. A Morlet wavelet analysis will be run to decompose the signal into frequency bands.

### EXPECTED RESULTS

The proposed study is in the process of being run and thus no data is currently available. Since participants only viewed right-handed reaches, it is predicted that the effect will be lateralized to the left hemisphere. There are also several other hypotheses that are being considered.

It could be that the participants are mapping the action of the actor onto their motor system, suggesting activation of the mirror neuron system. If this is the case, we might expect to see greater desynchronization of the mu rhythm in the affordance congruent condition for both ipsilateral and contralateral reaches than in the affordance incongruent condition. Another possibility is that the affordance of the

Figure 1. Still frames taken from stimuli: top row is the upright condition and bottom row is the inverted condition.



object does not affect our ability to activate the mirror neuron system. If this is the case, then we would expect to see similar patterns of mu desynchronization in both the inverted and the affordance incongruent condition as in the affordance congruent condition because all reaches would activate the mirror neuron system regardless of the affordance of the object.

One of the advantages of using the Morlet wavelet analysis is that both the time domain and frequency domain can be assessed. Thus, it is also possible to look at latency differences in desynchronization. It seems plausible that participants may be faster to map the motor representation of the reach during the congruent condition, a normal, everyday action, than they would be to map the motor representation of the reaches to the incongruent condition or to reaches towards the inverted cups. Thus, suppression may be observed later during these conditions than in the congruent condition.

## DISCUSSION AND CONCLUSION

This study has several advantages over previous studies. First, this study differs from previous studies in that it examines action observation during passive viewing rather than during a task which eliminates any possible confounds that could occur from activation of the motor system. In addition, instead of viewing still images of a completed action, participants in the current study watch the entire action. Finally, the participants view the entire upper body of the actor when performing a goal directed action. In much of literature focusing on object affordances and action observation, participants typically see the arm and hand of the actor but not the face or torso. Thus, the proposed study is more similar to what participants observe in daily life.

The current study hopes to disentangle the hypotheses mentioned above while also providing further insight into how action observation and object affordance are related. This study may provide further evidence for the idea that the mu rhythm can be used as an index of the mirror neuron system. Finally, the current study may provide important ideas for further research.

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# Cultivating a career: Effects of television binge-watching and character identification on college students' goal occupations

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## ABSTRACT

This paper focuses on the effects that heavy television viewing can have on viewers' life choices. Specifically, it investigates how television can influence their desires to be like favorite characters and to obtain a goal occupation that aligns with that of their favorite characters. This study surveyed undergraduate students at Indiana University to see if their favorite characters on popular career-based television shows could have influenced their major and career choice. Respondents were also surveyed to see if the act of binge watching heightened the likelihood of a viewer's goal occupation that corresponding with the career of their favorite character. The results showed that there was some correspondence between favorite characters' careers and viewers' goal occupations. However, the results showed no significant difference in the effects of binge watching.

**KEYWORDS:** cultivation theory, identification theory, communication, character identification

## INTRODUCTION

Most social scientific theories of mass communication share the idea that media has the ability to affect and shape aspects of the human experience, such as values and even decision-making. One particularly influential channel of mass media is television. Many studies have been conducted regarding the relationship between television consumption effects on viewers. Identification studies have shown that heavy television viewers tend to develop psychological attachments, or identification, with media characters. For example, Hoffner and Buchanan (2005) found that young adults tend to develop wishful identification with favorite television characters of the same gender as themselves and whom they perceived as sharing their own attitudes.

However, there is currently a gap in the literature regarding the ways in which frequent television viewing and identification with characters may influence young adults' perceptions of careers or college majors. Explicitly, we wondered if heavy-television viewing of career-focused shows results in viewers choosing majors that correspond with the career of their favorite characters. Additionally, the ability for viewers to binge-watch many episodes could amplify the correspondence between viewers' chosen career path and that of their favorite character.

To address these issues, we surveyed 734 students at Indiana University regarding their television viewing habits, their choice of major, goal occupation, and favorite television shows and characters. The aim of this study was to determine the possible affects that career-based television shows may have on viewers' decision for college major or goal occupation. The knowledge from this study allows us to better understand television's effects on human behavior.

## LITERATURE REVIEW

Identification theory holds that viewers can undergo an imaginative process in which the individual forgets his or

her own identity to take on the identity of someone else (Wolheim, 1973). Specifically looking at entertainment media, if one individual strongly identifies with a character in a show, a strong sense of aspiration to be that character could develop. This could cause them to follow the character's path in life, including choice of profession. For example, previous researchers found that a relationship does exist between occupational aspirations and amount of television watched (Hoffner et al., 2006). Prior literature also suggests that frequency of viewing and the extrinsic rewards of the favorite character's job, as well as income and education level of the favorite character, are all positive predictors of wishful identification (Hoffner, 2005).

Few studies have been conducted on media's portrayal of careers and the influence it can have on audiences. However, media's portrayal of groups in the workplace has been looked at. Although they did not empirically test their proposition, Harris and Sanborn (2014) identify the unrealistic solidarity amongst co-workers and professionals by the media and suggest it might influence audience members' career aspirations. The authors point out that shows like *The Office* and *Grey's Anatomy* depict the workplace as becoming a surrogate family (Harrison & Sanborn 2014). This workplace solidarity is also extended to the clients of the professionals. The doctors on *Grey's Anatomy* often spend their free time or days off seeking out or helping patients in need (Harrison & Sanborn 2014). Thus, an unrealistic portrayal of a profession might also influence career choices, particularly if a viewer relates strongly to one of the characters on that show.

According to Bandura's Social Cognitive Theory or Social Learning Theory, human behavior can be acquired through observation and modeling (Bandura 2001). This theory explains how individual's behavior can be shaped and developed by the observation of others. Many behaviors can be observed and modeled from the media, and mediated modeling of behaviors related to careers could possibly even influence one's decision to pursue a certain career.

While cultivation theory, social cognitive theory, and

research on audience identification with characters all suggest that there might be a relationship between television viewing and audience career goals, another factor may be at play in the modern media environment. Today, individuals can watch hours of their favorite shows all in a row instead of waiting to watch only one hour or half our per week. According to Matrix (2014), binge-watching platforms, such as Netflix, are changing how viewers watch TV and increasing the amount of TV they consume. Teen viewers reported in a Stage of Life study that they learned to set new goals and follow their dreams through watching their favorite shows (Matrix, 2014).

Based on the aforementioned literature, we pose the following two research questions:

RQ1: What is the relationship between the viewers' goal career and their favorite character's occupation?

RQ2: What is the relationship between binge-watching and occupation-based show and viewers' goal career?

## METHODOLOGY

### 1.1 Participants

Participants were recruited via a random sampling of students at Indiana University. The final sample of respondents ( $N = 734$ ), 34.6% identified as male, 61.0% identified as female, and 0.4% identified as transgender. Additionally, 79.4% of the final sample identified as White/Caucasian, 11.9% identified as Asian, 4.1% identified as Black/African-American, 1.0% identified as American Indian or Native Alaskan, and another 3.5% identified as "other" (respondents could select more than one race with which they identified. As for ethnicity, 7.4% of the final sample identified as Hispanic. The average age of the respondents in our sample was 22.88 years ( $SD = 5.35$  years).

### 1.2 Procedures

In order to randomly sample the student body (including undergraduate and graduate students) at a large public institution in the Midwestern United States, the researchers visited the registrar's office and viewed the publicly available (hard copy) list of student emails. There were 902 total pages of emails, and each page contained the email addresses of approximately 48 students. A picture of every ninth page (101 total pages) was taken with the goal of collecting approximately 5,000 email addresses. Due to the different number of names on each page, the final number of email addresses collected was 4,571. Those addresses were uploaded into Qualtrics software. Qualtrics was programmed to send a link to the online questionnaire along with information about the incentive to participate (entry in a random drawing for one of four \$50 USD gift cards to Amazon.com) to the 4,571 email addresses.

The questionnaire began with demographics, current major, and goal occupation inquiries. Then, the questionnaire asked general questions about binge watching before respondents reported their viewing habits of 20 popular television series. Each of these series is available to view online in some form, assuring that respondents could potentially binge watch them. At the end of the questionnaire, respondents were given the option to click on a link to separate website to enter their names and email addresses for the gift card drawing. This procedure allowed participants to enter the drawing without having their identity associated with their survey responses. The online questionnaire was open for two weeks and all procedures were approved by the university's institutional review board. Of those 4,571 individuals who were sent a message about the survey opportunity, four had email addresses that bounced back as undeliverable, but 2,234 people (48.9% of the deliverable addresses) did open the email. Of those, 750 students started the online questionnaire and 734 finished it, making for an overall completion rate of 16.1%, or 32.9% of those who actually opened the email.

### 1.3 Measures

After asking about demographics (i.e., gender, age, race, ethnicity), participants were asked about their goal occupation with the following prompt: "What is your goal occupation? That is, what do you ideally want your profession (your job) to be after you graduate?" Next, their responses were recoded by two coders into one of 33 general categories. Respondents were then asked if they had ever seen any of 20 popular television series. Table 1 details the results of this inquiry, with *Friends*, *How I Met Your Mother*, and *The Office* (US version) the most commonly seen in our sample.

For each show that respondents reported having seen at least once, they were then asked how they viewed the shows, with 13 different response options, ranging from watching it "when it airs (or when it originally aired) on TV," or "Single episodes online via the network/channel website or mobile app" to "Multiple episodes at a time on OnDemand." Five of those options were specifically designed to assess if participants binge-watched the show: "Multiple episodes at a time during marathons on TV;" "Multiple episodes at a time online via the network/channel website or a mobile app;" "Multiple episodes at a time on Netflix, Amazon, Hulu, or iTunes;" "Multiple episodes at a time on OnDemand (e.g., from your cable or satellite provider);" and "Multiple episodes at a time online for free using BitTorrent or similar websites." If a respondent chose any one of those five responses (or even multiple ones of them), we coded that as having binge-watched the show. Table 2 lists the percentage of viewers who binge-watched each show, with *Parks and Recreation*, *Friends*, and *How I Met Your Mother* being the two most popular binge-watching options of the 20 shows in our sample.

Table 1. Frequency of having seen the show at least once

Show	Frequency
Friends	454
How I Met Your Mother	403
The Office (US version)	394
Parks and Recreation	356
House M.D.	296
New Girl	275
Grey's Anatomy	273
Gilmore Girls	249
Sex and the City	228
Criminal Minds	224
House of Cards	216
CSI	179
Scandal	149
Castle	118
The Mindy Project	111
The X-Files	109
ER	105
The Blacklist	86
Entourage	80
Homeland	60

Table 2. Number and percentage of viewers who had seen a show and who reported binge-watching it

Show	Number who binged	% of those who had seen it
Friends	192	42.3
How I Met Your Mother	173	42.9
The Office (US version)	157	39.8
Parks and Recreation	168	47.2
House M.D.	84	28.4
New Girl	105	38.2
Grey's Anatomy	93	34.1
Gilmore Girls	91	36.5
Sex and the City	71	31.1
Criminal Minds	82	36.6
House of Cards	3	1.4
CSI	39	21.8
Scandal	64	43.0
Castle	28	23.7
The Mindy Project	29	26.1
The X-Files	29	26.6
ER	12	11.4
The Blacklist	26	30.2
Entourage	24	30.0
Homeland	20	33.3

## RESULTS

Final analyses were based on the five most popular shows in the sample (i.e., the five shows with the most respondents reporting as having seen at least once). These shows (*Friends*, *How I Met Your Mother*, *The Office*, *Parks and Recreation*, and *House M.D.*) included portrayals of a number of occupations, from actor or professor to government worker or healthcare provider. As such, they provided a nice cross-section of popular shows and popular occupations for which to address the research questions connecting styles of television viewing (binging versus tradition, single-show viewing) and the occupational goals of young adult viewers.

The first research question asked about the relationship between the viewers' goal occupation and their favorite character's occupation. Table 3 reports the percentages of viewers who had a match in between their stated goal occupation and their stated favorite character's occupation.

The second research question asked about the relationship between binge-watching a show and the match between the viewer's goal occupation and favorite character's occupation. To address this research question, statistical analyses were run comparing the number of respondents who reported any type of binge-watching of each of the five most popular shows in our sample against the numbers for each show who had a match in their goal career and their favorite character's career. First, a Pearson Chi-Square analysis was run with the 308 respondents who reported a favorite character on *Friends* other than the "other" option and using the continuity correction required for 2-by-2 tables. The analysis revealed there was a not a significant difference in the likelihood of having a career match with one's favorite character based on whether or not individuals binge-watched *Friends*,  $\chi^2(df = 1) = .22, p = .64$ . Another Pearson Chi-Square analysis was run with the 310 respondents who reported a favorite character

on *How I Met Your Mother* other than the "other option" and using the continuity correction required for 2-by-2 tables. The analysis revealed there was a not a significant difference in the likelihood of having a career match with one's favorite character based on whether or not individuals binge-watched *How I Met Your Mother*,  $\chi^2(df = 1) = .21, p = .65$ .

Another Pearson Chi-Square analysis was run with the 269 respondents who reported a favorite character on *The Office* other than the "other" option and using the continuity correction required for 2-by-2 tables. The analysis revealed there was a not a significant difference in the likelihood of having a career match with one's favorite character based on whether or not individuals binge-watched *The Office*,  $\chi^2(df = 1) = .03, p = .86$ . Another Pearson Chi-Square analysis was run with the 244 respondents who reported a favorite character on *Parks & Recreation* other than the "other" option and using the continuity correction required for 2-by-2 tables. The analysis revealed there was a not a significant difference in the likelihood of having a career match with one's favorite character based on whether or not individuals binge-watched *Parks & Recreation*,  $\chi^2(df = 1) = .00, p = 1.00$ .

A final Pearson Chi-Square analysis was run using only the data for those who reported having a favorite character on *House M.D.* other than the "other" option ( $n = 199$ ). This analysis also used the continuity correction required for 2-by-2 tables. It revealed there was a not a significant difference in the likelihood of having a career match with one's favorite character based on whether or not individuals binge-watched *House M.D.*,  $\chi^2(df = 1) = 1.01, p = .32$ . In summary, there were no statistically significant differences in the likelihood of having a match between one's goal career and one's favorite character's career based on having binge-watched the show.

## DISCUSSION

Our first research question asked if there is a relationship between the media viewers' goal career and their favorite character's occupation. Analyses determined that there is some association between the two; however, the correspondence is small. Nonetheless, these findings suggest that identification may be at play and influencing media viewers' career choice based on character occupation. *House M.D.* had the greatest percentage of character career/goal occupation alignment with a 13.9% of respondents having a match with their goal occupation and their favorite character's career. *Friends* was reported as the most watched show among respondents, and out of those 454 viewers, 3.52% had a match between their goal occupation and their favorite character's occupation. Most notably, 34.8% of the respondents who listed Ross as their favorite character also reported working as a professor as their goal occupation.

Identification serves as one possible justification for these character career/goal occupation matches. For instance, the reason *House M.D.* had the highest percentage of character career/goal occupation overlap could be due to the fact that all of the characters are flawed, and therefore more relatable, which could heighten identification in viewers. Foundational studies on identification have determined that perceived similarity is an important component of identification. The realistic portrayals of the *House M.D.* characters could strengthen identification bonds (Hoffner & Buchanan, 2005). Genre of the television show could also impact identification between viewer and character, as previous literature indicates stronger parasocial relationships between characters in dramas, such as soap operas, and female viewers (Kanazawa, 2002; Turner, 1993). Future studies could analyze other potential factors that may heighten the character/career matches.

Our second research question addressed whether binge watching strengthened the relationship between favorite character career and goal occupation. Results indicate that there was no significant relationship between a character career/goal occupation match and binge watching of the show. One possible explanation is that as binge-watching intensifies, other aspects of the character/viewer relationship, such as wishful identification with the favorite character's personality traits, may become more salient than the potential influence on career choice, especially in college-aged viewers. Future work in this area could study younger audiences who are likely less confident about professional aspirations, and therefore may be more impacted by binge-watching, in comparison to the college-aged students in the present work.

While this study provides important exploratory analyses of media effects at play between career aspirations, identification with mediated characters, and binge watching, no work is without limitations. For instance, the present study did not account for how each show portrayed the occupations of their characters, and if that affected whether

Table 3. Correspondence between favorite characters and goal occupations for the five most popular shows in the sample

Show	Seen Show	Favorite Character	Goal occupation matches favorite character's occupation
Friends	454	Ross - 23	8 (34.8%)
		Monica - 31	0 (0%)
		Chandler - 91	7 (7.7%)
		Joey - 43	0 (0%)
		Rachel - 66	1 (1.5%)
		Phoebe - 54	0 (0%)
		Other - 15	N/A
How I Met Your Mother	403	Barney - 133	0 (0%)
		Ted - 39	0 (0%)
		Marshall - 70	6 (8.6%)
		Lily - 36	10 (27.8%)
		Robin - 32	0 (0%)
		Other - 14	N/A
The Office (US version)	394	Dwight - 48	2 (4.2%)
		Michael - 77	6 (7.8%)
		Jim - 98	1 (1.0%)
		Pam - 19	1 (5.3%)
		Angela - 5	0 (0%)
		Andy - 3	0 (0%)
		Phyllis - 1	0 (0%)
		Creed - 8	0 (0%)
		Oscar - 1	0 (0%)
		Darryl - 2	0 (0%)
		Kelly Erin - 1	0 (0%)
		Kelly Kapoor - 6	0 (0%)
		Other - 9	N/A
Parks and Recreation	356	Leslie - 89	5 (5.6%)
		Ron - 80	3 (3.8%)
		Tom - 19	1 (5.3%)
		April - 26	1 (3.8%)
		Andy - 14	1 (7.1%)
		Ann - 3	1 (33.3%)
		Ben - 3	0 (0%)
		Chris - 5	1 (20%)
		Jerry - 2	0 (0%)
		Donna - 3	0 (0%)
		Other - 7	N/A
House M.D.	296	House - 148	32 (21.6%)
		Foreman - 7	1 (14.3%)
		Wilson - 15	4 (26.7%)
		Chase - 8	0 (0%)
		Cuddy - 9	1 (11.1%)
		Cameron - 4	1 (25.0%)
		Taub - 1	0 (0%)
		Thirteen - 7	2 (28.6%)
		Other - 4	N/A

there was a character career/ goal occupation match. For example, *The Office* is considered a largely popular show; respondents rated it as the third most-watched show with a total of 394 viewers. However, only 2.53% of those

respondents had a match with their goal occupation and favorite character. There may be a significant relationship between the way the sales careers are portrayed in *The Office* and desirability of the career with regard to viewers' goal occupation. Michael Scott may be a lovable and favorite character to many, but only 7.8% of respondents who listed him as their favorite character had a goal occupation match with his occupation. It's possible that being the regional sales manager of a paper company in the Midwest might not be portrayed as an appealing career, especially when the crux of cultivation theory – that media can cause people to believe that mediated portrayals correspond to actual reality – is considered (Gerbner, 1998).

While further research is needed to systematically parse out the relationship between binge watching and the aforementioned identification and cultivation effects, this study presents an important, exploratory examination of how present-day media viewing trends may be impacting the viewer relationships with mediated characters.

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# Decentralization from Above, Dispossession by Recognition: Contradictions in Tanzania's New Wave Land Reforms

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## ABSTRACT

Recent decades have seen a surge in land reform throughout Sub-Saharan Africa, largely described as “new wave” land reforms aiming to promote rural development through decentralization and formal recognition of claims to land. Focusing on Tanzania, a country with historically highly centralized land management, this investigation examines how new legislation, in particular the 1999 Village Land Act, has attempted to address both local concerns and international pressures and evaluates how successful reforms have been in terms of both. This paper analyzes these reforms in the context of neoliberalism and the related “pro-poor growth” model, which advocates for the formalization and marketization of land titles as a long-term solution to rural poverty. It first provides a theoretical background on the debates surrounding land reform strategies and then examines specific examples from reforms in Tanzania.

Tanzania's reforms have been guided both by local grievances (such as lack of clarity and security regarding access to land) and international pressures (desiring, among other things, greater ease of foreign investment and the creation of a rural land market); as such, issues have frequently arisen in attempting to reconcile sometimes contradictory demands and determining priorities. The results of reforms have been mixed. Formalization, in particular, has shown the potential to exacerbate inequality instead of reducing it, and the process of formalization itself can lead to an increase in conflict over land. However, reforms have also opened new avenues for previously marginalized groups, such as pastoralists, to secure land access through participation in civil society.

**KEYWORDS:** land reform, land grabbing, Sub-Saharan Africa, Tanzania, new wave, formalization

## INTRODUCTION

Following the transition from state-centered development plans to a neoliberal framework and the “rule of law,” the past few decades have seen a surge in land-related reforms in Sub-Saharan Africa. These reforms have been characterized by a push for the formal recognition of land tenure rights (including customary rights), greater transparency and clarity in legislation concerning land, the creation of efficient land markets, and decentralized land management. In Tanzania specifically, a country with a history of highly centralized and undemocratic land control, reforms starting in the late 1980s have attempted simultaneously to address demands from previously disenfranchised groups and implement reforms advocated by international financial institutions and development agencies. This attempt to use reforms to address local concerns while simultaneously pleasing investors and meeting international expectations has resulted in contradictions both in policy and outcome. While these reforms have demonstrated success in many instances and potential for future improvement in others, they have also aggravated problems at times and led to more, not less, confusion regarding land tenure; implementation, moreover, has been an issue in itself. This investigation focuses primarily on Tanzania's landmark 1999 Village Land Act, a central reform, though not the only one that took place at the time. It also examines occurrences since then, examining the conditions that led to its design and the roles of different actors. Situating the reforms in a theoretical framework of “pro-poor growth,” it reviews the literature surrounding recent African land reforms and then focuses on Tanzania,

bringing in examples from different case studies bearing on the Act's implementation, or lack thereof.

## TERMINOLOGY AND CONTEXT

A brief definition of some terms related to landholding is appropriate before a discussion of land reforms. Key distinctions are “customary” versus “granted” rights and “land ownership” versus “land tenure.” In the Tanzanian context, land refers to the surface of the earth, everything underneath other than petroleum and minerals, and everything on top of the land (water, plants, buildings, etc.). Land tenure, which is the applicable description for the Tanzanian system, signifies the manner in which residents have claim to the land; they do not ultimately own the land that is in their name, but they do have the right to occupy and use it for a specific amount of time (typically ninety-nine years); all land in Tanzania is ultimately public land, held by the president in trusteeship for the “benefit of the nation” (Rwegasira, 2012). Finally, the definition of customary rights to land is politically significant; while in general it refers to rights deriving their legitimacy from tradition and historical tenure, in Tanzania the working definition is “the current land usage patterns in village land” (Fairley, 2012, p. 8). Granted rights, in contrast, are those which are explicitly given by the government to an individual who previously did not have claims to them (Rwegasira, 2012).

Tanzania's new land reforms have been described as “new wave” land reforms. As defined by Rasmus Pedersen of the Danish Institute for International Studies (DIIS), new wave reforms consist of three elements, all of which

are present in the Tanzanian case: an immediate recognition of existing (customary) claims to land, decentralization, and formalization (formal/official recognition and recording) of land claims, which ideally both improves tenure security and facilitates the creation of land markets. This contrasts with previous land reforms, which focused on land nationalization, redistribution, and/or individualization of land tenure and an abandonment of customary rights (Tanzania's New Wave Land Reform, 2014).

\*The reforms discussed in this essay concern solely mainland Tanzania. Zanzibar (an autonomous region within Tanzania) has its own land tenure system, which will not be discussed here.

\*\*Although it may be somewhat imprecise, for the sake of convenience, the word "landholder" or "land user" will be used here to refer to those living on and using a tract of land, regardless of whether they have formal rights/ownership or not.

## THE HISTORY OF LAND TENURE AND LAND LAW IN TANZANIA

Land law and land tenure systems in Tanzania, as throughout Sub-Saharan Africa, bear a strong imprint of a tumultuous history, displaying the legacy of pre-colonial, colonial, and post-colonial systems and the transformations associated with each of them. Prior to German occupation, there existed various land tenure systems associated with the political structure of different societies; specifically in agricultural societies, land was generally managed under communal or feudal systems, with local authorities such as chiefs controlling distribution and resolving conflicts. Upon occupation, German colonizers recognized indigenous claims to land native populations inhabited or used, but they transferred all unoccupied territory to the Crown. Additionally, they excluded native inhabitants from purchasing land, and customary land tenure, while recognized, was given inferior treatment as landholders were not able to access registries. The British, who took over Tanganyika (mainland Tanzania) after World War I, maintained a system of indirect rule through local chiefs, maintaining many groups marginalized and forcibly resettling some populations (Rwegasira, 2012).

After Tanganyika's obtaining independence in 1961 and merging with Zanzibar to form Tanzania in 1964, land administration changed significantly. Tanzania's first Prime Minister, Julius Nyerere, viewed the traditional land system largely controlled by local chiefs as inimical to his ideas of Ujamaa (African socialism), national unity, and economic modernization. Maintaining the colonial policy of vesting all land ownership in the central government, he stripped these chiefdoms of their political power and nationalized all land, although chiefdoms continued to have an important informal role (Pedersen, 2015). In its first post-independence decades, Tanzania experienced a significant degree of agricultural collectivization and forced resettlement as part of its "villagization" program,

which entailed the designation of socialist villages (vijiji vya ujamaa) and at times violent coercion of citizens into resettling there. New villages and boundaries were drawn and formalized as part of this policy in 1975, and locally accountable village councils were formed in order to manage them. Already by the early 1980s, however, there were clear signs of problems stemming from the government's centralization; among other things, agricultural productivity had fallen precipitously. As such, Tanzania started moving away from the steadfast socialist policies it had maintained previously; it greatly eased the restrictions on private enterprise and started allowing private land ownership and a new market in land in 1983. This new market, in combination with a lack in legal infrastructure to handle it, led to an upsurge in land-related disputes by the late 1980s, prompting the national government to start considering a systemic overhaul. It appointed a Presidential Commission, headed by Tanzanian legal scholar Issa Shivji, to investigate land disputes and propose solutions. The report advocated, among other things, for far-reaching devolution of control of land matters to local governments and for the establishment of a clear and functional mechanism for the resolution of land disputes. These steps, which had begun in the 1980s, arguably culminated in the passing of the 1999 Land Acts, which included both a Village Land Act dealing with village, i.e., most rural land, and a Land Act, which dealt with urban land and other land not covered by the Village Land Act. Shivji's proposals were heeded up to a point but did not involve the extent of decentralization he desired; ultimately, the acts were drafted with the help of international consultants (who received funding from the World Bank and British government) and followed the recommendations of the Minister of Lands, Housing, and Human Settlement Development (hereafter referred to as Minister of Lands) (Pedersen, 2015).

## THE 1999 VILLAGE LAND ACT: A SUMMARY

Praised by many for its progressive nature, the 1999 Village Land Act, together with its accompanying 1999 Land Act, has been a major source of discussion and study within the development sphere. Aiming to devolve control (i.e., return a greater degree of control to lower/more local levels of government), clarify the rights and responsibilities of different stakeholders, and strengthen the land rights of villagers (in particular commonly marginalized groups, such as women and pastoralists), the act did away with the last remnants of British law remaining in the Tanzanian system. Key points of the (quite extensive) law include the following: the redesignation of the Village Council (elected every five years by an assembly in which all village adults can participate) as "land manager" instead of the "land owner" it previously was; a pathway for the formalization of customary claims to land, as well as safeguards for customary landholders that do not wish to formalize their claims; the requirement for the central government to provide compensation for the very

land itself taken from residents in addition to the crops and buildings on it; the delineation of different categories of land; and the mechanisms for villages and individual residents to determine their territorial boundaries, among others (Wily, 2003). Shortly afterward, in 2002, Tanzania also passed a Land Disputes Settlement Act as part of this same “wave” of reforms.

## THE NEOLIBERAL APPROACH TO LAND

A discussion of Tanzanian land reforms should be placed in a global context; after all, Tanzania is but one of the many countries in Sub-Saharan Africa carrying out major land reform, and many of the tendencies visible in the reforms are inextricably linked to major worldwide trends, including neoliberalism and new approaches to development. In the “Postface” to his book *The Road from Mount Pèlerin: The Making of the Neoliberal Thought Collective*, historian Philip Mirowski enumerates eleven axioms of neoliberal philosophy, providing a definition of neoliberalism that recognizes its epistemic as well as economic characteristics. Among these tenets he lists the necessity for the deliberate construction of a market state, which must thereafter be presented as the “inexorable” state of society; reliance on the market as the ultimate allocator of goods and services; the promotion of a highly circumscribed definition of “freedom” and a view of individuals as atomistic, rational actors; and the presentation of neoliberal ideas as a “moral code” (2009). Using this understanding, the reforms advocated by international development agencies and financial institutions largely fit within the neoliberal framework, while demonstrating some divergence. As described by legal scholar Ambreena Manji, land reform in Tanzania (and indeed throughout Africa) has largely concentrated on diffusing a normative view of individual, legally defined rights to land, in combination with functioning land markets. However, perhaps a more appropriate term is “pro-poor growth,” which recognizes the importance of functioning markets as a key to improvement in living standards but also focuses explicitly on reducing income inequalities and protecting marginalized groups (on the other hand, many definitions of neoliberalism, including Mirowski’s, specifically list inequality as a necessary condition). Pro-poor growth, as well as neoliberal reforms in general, commonly appeal to an ideal of “good governance,” viewed as necessary for the functioning both of society and markets, including adherence to contracts, transparency, etc. (Federal Ministry for Economic Cooperation and Development, 2006).

A major influence on land reform in the pro-poor context has been the work of Peruvian economist Hernando de Soto. A vigorous proponent of land title formalization, de Soto has argued that land title formalization provides legal and financial certainty for landholders. This certainty affords them the security to carry out long-term investments on their land, increasing productivity in the long run.

Furthermore, formal titles to property could potentially enable owners to put this property up as collateral to take out loans, which can be used for various purposes, including investment in entrepreneurial activities. His views have been espoused enthusiastically by the World Bank and the British Department for International Development (DFID), which, among others, have started to advocate for such an approach (Stein & Cunningham, 2015).

## CRITICISMS OF THE “NEW WAVE” APPROACH

The role of legal reform as a catalyst for development is not unproblematic, as many critics readily point out. In her book *The Politics of Land Reform in Africa*, Ambreena Manji argues that recent land law reforms (the “new wave reforms” mentioned earlier) serve as a way to avoid dealing with land redistribution, which in her view is what is truly necessary to solve problems of inequity. A major criticism of this legalistic approach is its imposition of Western concepts out of context: according to Manji, reforms aiming to establish “rule of law” are explicitly promoted by industrialized capitalist countries to force the developing world into capitalist labor relations, the lack of which is largely considered to be a major cause of underdevelopment (2006). Furthermore, the imposition of rule of law and capitalism follows an “evolutionary” model of thinking, whereby countries are seen to be at various stages of development, with the ultimate (and inevitable) goal of reaching the state of development of Western countries. While in and of itself this approach opens itself to criticism, Manji also argues for a distinction between using the rule of law as a method of development and seeing it as an end goal of development, a distinction that, in her view, proponents of rule of law collapse. She describes a debate between Issa Shivji and British legal scholar Patrick McAuslan on the appropriate role of legislation in land reform: while McAuslan (who has served as a legal consultant for land reforms in East Africa) advocated for a more detailed, explicit, and expansive body of laws dealing with all aspects of land tenure issues in Africa, Shivji argued for more concise laws allowing local officials and administrative bodies more discretion in order to better address localized problems (Manji, 2006). It bears repeating that both Shivji and McAuslan vociferously opposed abuse of governmental power; however, they differed in their view of the solution, with McAuslan placing trust in the capacity of the legal system and Shivji in local actors.

A third point of criticism commonly leveled at neoliberal reforms, and indeed any reform implemented out of its original context, is their simplistic assumption of actors’ motivations and, even more basically, homogeneity (indeed, as described by Mirowski, a view of humans as “atomistic” and rational actors). This erroneous assumption becomes evident at many levels: the village, the household,

different users, etc. One issue is the oversimplification of user rights in many African land regimes. In many contexts, various users can enjoy different types of rights to land; these include primary rights, such as the right to undertake cultivation, secondary rights, such as grazing or gathering other resources after harvesting is complete, and/or seasonal rights (Stein & Cunningham, 2015). Formalization programs typically acknowledge only primary rights and thus exclude users with other types of rights, essentially “enclosing” land that may have provided them with necessary safety nets; as the poor in particular may depend on non-primary rights, the oversimplified formalization of land titles may have the effect of rendering them more vulnerable. A second homogenizing assumption typical of formalization programs is that of equal economic status of rural inhabitants. Claims to land in informal tenure systems often overlap, and formalization, being a costly procedure requiring access to information and officials, can favor those with the means to acquire formal land titles. In the process, poorer land users can become disenfranchised, a situation which replicates and exacerbates inequality, as it legally blocks the informal access poorer users may have previously had to land (Stein & Cunningham, 2015). Finally, land law reforms are notorious for their assumptions of intra-household homogeneity. In her book, Manji argues that a primary reason owner-operated farms are viewed as more efficient than farms operated by waged labor is that owners of farms need not pay themselves, thus avoiding hiring, management, and labor-related expenses. However, it is women who often bear the greatest burden in agricultural work but men who typically have both legal and domestic power. As such, without very explicit precautions, such as co-titling of land to both male and female household members, formalization can legally facilitate the exploitation of women, who can be shut out of the process. Different countries have taken various measures to combat the problem of gender inequality in land access, including co-titling requirements and female representation in village councils, but Manji describes these as unsatisfactory, going so far as to argue that intensified productivity is itself predicated on the need for female exploitation (2006).

Another major objection raised by many to new wave reforms is the increased vulnerability of landowners to dispossession. In her work, Manji questions the advisability of exposing smallholders to losing their one productive resource, land; putting up land as collateral for investments, while potentially beneficial for those smallholders successful in their investments and entrepreneurial activities, places owners at the risk of falling in debt and losing their land. Finally, formalization of land claims involves the drawing and legal recognition of boundaries; observers fear that these boundaries have in many instances been drawn in a way that alienates villagers from land previously accessible to them for the purpose of purchase by outside investors (Stein & Cunningham, 2015).

## EVIDENCE FROM TANZANIA: THE NEW REFORMS, BENEFITS, DRAWBACKS, AND CASE STUDIES

The situation of small landholders in Tanzania has continued to be quite mixed since 2001, when the Village Land Act came into force. There have been improvements for some, but many elements are still found lacking, and both policy and practice have been riddled with contradictions and inconsistencies. One of the criticisms of the land act is its awkward combination of decentralized decision-making with highly centralized, and arguably undemocratic or inefficient, elements. For instance, Village Councils can approve or reject transfers of village land of sizes up to 250 hectares; however, any transfer greater than that is handled by the Minister of Lands, and the village has no say in the matter, even though, logically, the village would be more affected by a larger transfer than a smaller one. Additionally, although Village Councils are in charge of authorizing most proceedings that take place, all Certificates of Customary Rights of Occupancy (CCROs), which formalize customary claims to land, must be signed by the District Land Officer; since districts have an average of approximately eighty villages (if one divides the number of villages in Tanzania by the number of districts), this requirement significantly slows down the process (Wily, 2003). A third issue is an unclear definition of customary law: the land act explicitly acknowledges the legitimacy of traditional/customary ways of handling land and allows for their use, as long as they do not discriminate against marginalized groups or conflict with any other applicable law. However, it defines “customary” in terms of the previous twelve years (presumably because of the complexity of the rural transformations that took place shortly before 1987, i.e. during villagization). This definition does not make clear what customary laws are to be followed in case of divergent opinions as to what constitutes tradition (Wily, 2003); this fact can lead to institutional competition, in which landholders can choose to appeal either to formal or informal methods of conflict mediation (Pedersen, 2014).

## THE CONTRADICTORY ROLE OF THE STATE

Popular discourse about states implementing externally advocated reforms often poses them either as powerless in the face of international financial institutions and corporations or as corruptly complicit in the exploitation of their own citizens. At least in the Tanzanian experience, the situation is much more complex. While Tanzania has definitely undergone pressure from various international actors, there is little empirical evidence indicating, for instance, that Tanzania implemented its land reforms due to donor demands. In fact, Pedersen points out that Tanzania’s reforms were motivated by internal political processes, though certainly encouraged by donors (Pedersen, 2015).

Concerning reform objectives, one could definitely say that the state is conflicted. On one side, it has taken steps seeking to strengthen citizens' rights to land vis-à-vis their own government, and there are indications that these are more than just appeals. Among other things, individuals, empowered by new legal protections, have been winning in court cases against the state itself (Ujamaa Community Resource Team). On the other hand, a great deal of land appropriation continues to take place, often for the purpose of foreign investment, an objective the government explicitly acknowledges guided the reforms (the central government has in fact explicitly stated regrets about the difficulty of obtaining land for investors!) (Stein & Cunningham, 2015). Among other things, large-scale agricultural initiatives, such as the Southern Agricultural Growth Corridor of Tanzania (SAGCOT), have been a source of concern for citizens fearing appropriation. Recent estimates state that there are more than 1,000 land disputes annually involving confrontations between investors and villagers (Kasumuni, 2012). Much of the blame here is also leveled at the government for its lack of enforcement and abuses of power, including eviction without compensation.

## PRACTICE IN TANZANIA

Studies carried out more recently provide information on the law's actual implementation. Evaluations differ quite significantly, making it difficult to make general conclusions, in combination with the fact that any large area will have variations in outcomes. In a paper presented to the World Bank in 2012, Elizabeth Fairley states that there is no empirical evidence that the government has intentionally redrawn village boundaries to appropriate land. However, she does state that land formalization has resulted in other conflicts. In situations where boundaries previously were typically ambiguous, formalization has often led to bitterness between villages, as formalization officially excludes others from land in a way that customary use does not, and a party can feel aggrieved when land it considered rightfully its own is formalized in someone else's name. Furthermore, due to the necessity of formalizing village boundaries to be able grant CCROs, in combination with the slow pace of bureaucratic processes, villages often end up acquiescing on their claims just as a matter of practicality. She lists multiple examples in pilot areas, including disputes over access to sacred sites and the encroachment of one village onto another's farmland (2012).

An issue Fairley discusses in depth is the use of land as collateral and the impact of that on desires for formalization. As she describes, landholders in the implementation pilot project areas in general did desire to formalize their land, but in most instances, their sole motivation was the possibility of using their land as collateral to obtain loans. This fact would support de Soto's argument in favor of widespread formalization, although, interestingly, the most common reason stated to want to take out a loan was actually to pay children's school fees, not for investment in agriculture

or business. However, most people interviewed by Fairley were rather uninformed on the details and conditions of loans, specifically the possibility of losing one's land if one defaulted on the loan, indicating the possibility (in support of Manji's argument) that formalization could lead to a greater amount of landless rural poor. Moreover, most people who did formalize their land did not succeed in getting loans approved by banks anyway, so interest in formalization fell over time. This was compounded by the fact that later applicants had to bear a greater cost of the formalization themselves, as certifications in the first pilot projects were fully covered by World Bank funds. The concern that formalization benefits those with greater economic means is well-founded in Tanzania; Fairley notes that, in her case studies, it appears to be that landholders with greater means more frequently obtain CCRO's, as the cost of filing can deter those with lesser means (2012).

## DEMOGRAPHICS AND LAND CONFLICTS

One issue that formalization does appear to aggravate is that of competing claims to land due to demographic shift and increasing pressure on land. Tanzania's population has increased from eleven million in 1963 to over forty-five million currently. Although it has a relatively low population density in comparison to other countries, this growth is significant and has undoubtedly increased competition for resources where there was previously less need for competition (challenging traditional views of Tanzania, and indeed Africa overall, as a place where land is always abundant) (Odgaard, 2002). Furthermore, various factors, including resettlement during the colonial and post-colonial periods, economic change and increased mobility, and geographic differences in resource endowment and population density, have caused significant demographic shifts throughout the country. This has brought ethnolinguistic groups into locations new and traditionally "foreign" to them, at times resulting in tension with groups living there longer. Pastoralists in particular have extended their geographic range of residence and migration (Kitabu). In a discussion on settlements in Iringa Region in southwest Tanzania, Rie Odgaard notes the distinction made by many residents between *wenyeji* (locals) and *wageni* (foreigners/outside, i.e., those who have migrated in more recent years to the region). The distinction between belonging to the *wenyeji* or *wageni* has a significant effect on the social legitimacy of one's claim to customary land, and with increasing pressure on land, people have started appealing to indigenous customary rights. Indigeneity would not be seen as so significant were there less pressure on land (Odgaard, 2002).

In a more tragic case, Maasai herders (whose traditional homeland is considered to be north-central Tanzania, in an area comprised of Arusha and Manyara Regions and close to many famous game reserves) have recently extended their migrations down to Morogoro Region in central-

eastern Tanzania. Throughout that region, there have been recurrent clashes between pastoralists and farmers, at times leading to fatalities. Pastoralists are blamed for degrading the environment through overgrazing and misuse of water sources (Kitabu, 2012) and letting their herds trample crops (Makoye, 2014), as well as bribing local officials. Many point to governmental inadequacy and corruption as an ultimate cause; officials, in violation of the Land Acts, evict pastoralists to clear space for investment without compensating them, forcing them to move elsewhere. In accordance with the 1999 Acts, villages should have a land use plan to prevent disagreement on land use, but many have not drawn one out yet (Makoye, 2014).

## COMMUNAL LAND RIGHTS

Large-scale land appropriations and forced evictions are not new in Tanzania or Africa, and they took place at a large scale during the colonial and post-colonial periods for various reasons. However, the growth of private investment by both foreigners and nationals is particularly concerning for many reasons, especially in light of increasing competition for resources. Although the Village Land Act does allow for land appropriation, which has been carried out unfairly many times in practice, certain provisions have enabled local residents to defend their claims in actual practice. In a liberalized age, non-governmental and civil society organizations, both national and international, have been able to play an important and at times successful role in defending rights of vulnerable groups. An innovative right in the 1999 Village Land Act is the possibility of issuing a Certificate of Customary Right of Occupancy to an entire group, making it possible for groups such as pastoralists to secure access to communally-held land. Typically, communal land is defined in village land use plans (if these have been drawn up). However, Village Councils can easily change the designation of this land (which is often seen as unused and abundant with resources), which can happen when pastoralists are a minority. A defense against this would be a group CCRO, provided for in the 1999 Acts; however, the first group CCRO in all of Tanzania was issued only in 2011 (Ujamaa Community Resource Team). The Ujamaa Community Resource Team (UCRT), working in northern Tanzania, successfully secured group CCROs for four different pastoralist and hunter-gatherer tribes, including the Hadzabe and Maasai, securing over 300,000 hectares overall (Goldman Environmental Foundation, 2016). The group CCRO makes it difficult to subdivide land (an important protection in the case of communal land), as all users must agree to the subdivision. This model shows potential applicability throughout Tanzania and could be an important strategy for otherwise vulnerable pastoralists. In fact, a UCRT program director, Edward Loure, won the 2016 Goldman Environmental Prize for Africa for his work with pastoralists and communal land (Goldman Environmental Foundation, 2016), group CCROs listed as one of his main achievements. This could be of great significance for

pastoralists, who have disproportionately suffered eviction for the formation of national parks and game reserves. Forced eviction, both of pastoralists and farmers, has often taken place, and continues to do so, often under environmental pretexts (Kitabu, 2012).

## CONCLUSION

Tanzania's experience with land reform, in combination with current demographic and economic trends, has been quite varied, showing both steps toward inclusiveness and signs of dispossession. This is the case when appeals to transparency are accompanied by lack of implementation and abuse of power and when decentralization is simultaneously encouraged and contained. The state and central government is arguably the actor with the most agency; however, its capacity is more limited in practice than in theory, and one must keep in mind that it is not a unified, homogeneous actor, as neither are international donors. The current situation with land rights does provide many instances of problems arising from the combination of a neoliberal/pro-poor framework to a new context but also the results of well-meaning actors aiming to reconcile various realities. Many of the issues occurring today are not uniquely due to the reforms, but they do still speak to a changing political and economic environment. Future developments may indicate a strengthening and harmonization of rights, or they may not.

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# Politics in African Wildlife Conservation: Wildlife Management Areas in Tanzania

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## ABSTRACT

Starting in the 1980's, an increasing number of international actors have advocated for a change in wildlife and resource conservation strategies, arguing for practices allowing for greater local management in a model known as "community-based conservation." Focusing on Tanzania, a country known for its expansive wildlife and game reserves, this investigation examines the adoption and implementation of legislation allowing for locally-administered Wildlife Management Areas (WMA's). This paper first documents the processes motivating the introduction of WMA legislation in Tanzania, then details the legislation's contents themselves and attempts to evaluate the social and political results as best it can, using a combination of sources including previously conducted research, promotional materials, and NGO publications.

Major aspects of legislation include the following: villages themselves choose to enter into WMA agreements with investors; investors collect the revenue and deliver it to the federal government, which in turn distributes it to villages and wildlife conservation programs; and village residents themselves determine how to allocate the revenue they receive. Results have been mixed; while many villages have benefitted from income received from participation in wildlife management, there have also been instances of coercion into participating, disputes between villages regarding WMA practices, and there has been a general lack of transparency in income collection and distribution. Furthermore, it is unclear to what extent recent legislation has actually given a greater degree of control to local government.

**KEYWORDS:** conservation, Tanzania, wildlife management, politics, conservation, African politics

## INTRODUCTION

In his book *Economic and Political Reform in Africa*, anthropologist Peter Little quotes an elderly Kenyan Samburu woman as stating her community now "milks elephants as [they do] cows" (Little, 2013, p. 64), obtaining income from wildlife; he contrasts this with the experience of the residents of Narok County in southern Kenya, where disputes over control of protected areas have historically led to violence. Both cases are instances of a (relatively) new conservation model, "community-based conservation" or CBC, which recognizes the importance of participation by local residents in conservation projects and the benefits these residents can obtain from such projects. Both Little's chapter on community-based conservation, as well as *Milking the Rhino*, a documentary about it, emphasize the contingent nature of its successful implementation, the heterogeneity of a community's actors, and the uncertainties involved in implementation; Little, furthermore, describes the highly politicized nature of conservation and the inequalities exacerbated by conservation efforts. These materials provide an overview of community-based conservation in a few settings (Namibia and Kenya) and allow for further questions to be asked. Topics of interest include, among various others, the intersection of conservation and development, the role of national vis-à-vis international actors, and actual changes in the places where new policies have been applied. This essay incorporates all these issues while seeking to address the following question: how have new approaches to wildlife conservation in Africa shifted power relations and beneficiaries? Using Wildlife Management Areas (WMA's) in Tanzania as a focus, this

investigation finds that, at least in the Tanzanian context, community-based conservation approaches have formally created more participatory structures; however, benefits have remained ambiguous, and changes in power (here signifying influence on the outcomes of decisions) have not been very significant, though there might be potential for future devolution (transfer of control to lower/more local levels of government).

In his chapter, Little uses the term "community-based conservation" to refer to a broad set of policies and approaches to conservation and sustainable resource use. Other authors use this term somewhat differently; in the book *African Wildlife and Livelihoods: The Promise and Performance of Community Conservation*, researchers Edmund Barrow and Marshall Murphree (2001) categorize what they term "community conservation" into three categories: protected area outreach, collaborative management, and community-based conservation. "Protected area outreach" refers to the establishing of special regulations in areas surrounding protected areas (such as parks) in order to ensure the biological integrity of the protected area themselves, allowing wildlife to roam beyond park boundaries onto private or village land; "collaborative management" refers to the joint management of natural resources by conservation authorities and local users; and (Barrow's and Murphree's definition of) "community-based conservation" describes the transfer of formerly centralized control to local communities in order to promote sustainable use and livelihoods. This last category is also often labeled "community-based natural resource management" or CBNRM. These categories are rough

delineations, and a project can include elements of more than one, but they do provide a useful way to understand an otherwise extremely broad array of diverse approaches and cases. Conservation (itself an extremely broad term) can apply to a great deal of different resources, but (as stated in their label) WMA's primarily concern wildlife conservation, particularly fauna, which has occupied a particularly large role in the African context. Tanzanian WMA's fall both under the CBNRM category and protected area outreach, as they are located primarily on the borders of official protected areas.

## A BRIEF HISTORY OF AFRICAN WILDLIFE CONSERVATION

A discussion on African wildlife conservation must be situated in its historical context. Particularly salient in East and Southern Africa are protected areas such as national parks and game reserves, which are largely a direct inheritance of the colonial system. Both British and German colonizers in Africa created a system of game reserves with the exclusive purpose of recreational hunting and species conservation, being attracted by the "charismatic" and abundant wildlife there; this process entailed designating wildlife-rich areas, closing them off to native use and forcibly removing previous inhabitants (Jones, 2006, p. 485). In these artificially uninhabited areas, such as Krueger Park in South Africa and the Selous Game Reserve in Tanzania, white colonialists were able to hunt large land mammals for sport, while indigenous inhabitants that did the same (even for purposes of sheer survival) were punished as poachers (Jones, 2006).

The end of the colonial period and establishment of independent states brought about major changes in African politics and society, but there remained many aspects of the colonial legacy; one such aspect was wildlife conservation. Many national governments reneged on promises made to their citizenry, retaining game reserves or converting them to full-protection national parks, as wildlife had potential income benefits for governments (Jones, 2006). The conservation model maintained here was known as the "fortress," "command-and-control," or "fences and fines" model, whereby government attention was concentrated inside the park, with access restricted to local populations; however, territory outside the park fell outside of the purview of conservation (Little, 2013).

## A NEW APPROACH: COMMUNITY CONSERVATION

Several factors came together by the early 1990's leading to a paradigm shift in conservation in Africa. At a time of rhetoric advocating for the retreat of state involvement and an increase in the role of private actors and good governance structures, calls for increased community involvement in conservation very much appealed to international donors, and since national governments underwent large cuts

in spending as part of neoliberal reforms, community involvement could replace government patrolling (Little, 2013). Little attributes the rise of the CBC model to the rise of the neoliberal paradigm, and, though correct in recognizing this, he does overlook some other factors that also played a role. In particular, ecological science itself became increasingly cognizant of the relationship between humans and their environment, and approaches divorcing humans from ecosystems to be preserved (such as the previously mentioned fortress model) came under scrutiny (Berkes, 2004). In addition, the idea of sustainable development started gaining popularity around the same time, drawing attention to the mutually reinforcing relationship between ecological stability and positive development outcomes (Berkes, 2004). Specifically in Tanzania, poaching levels had halved elephant populations and nearly eliminated black rhinoceros (United Nations Development Program, 2015), and it was becoming increasingly apparent that the current fortress approach was not as effective as desired.

## WILDLIFE MANAGEMENT AREAS IN TANZANIA

Calls for community involvement may be appealing in theory, but the reality on the ground often ends up quite differently. Officially, in Tanzania, villages themselves decide to organize and agree to form a WMA. The 1998 Wildlife Policy, together with the first WMA Regulations in 2002, detail the process by which villages do so (WWF, 2014). A group of villages agrees to set apart a certain amount of land for the WMA (withdrawing this land from other uses), form and register a community-based organization (CBO), and prepare legislation surrounding the WMA. The CBO then applies for Authorized Association (AA) status and can then formally enter into agreements with investors, which can include private companies and NGO's; partnership with outside entities can often be essential, given the lack of financial resources that many WMA villages command individually. WMA's can receive income from various tourist activities, including sport hunting (allowed in Tanzania), safari tours, photographic tours, and lodging on WMA grounds (WWF, 2014). Income from WMA activities is distributed in the following way: investors collect the revenue and deliver it to the federal government, which allocates 35% to its wildlife division and 65% to the WMA/AA. Half of this amount is divided evenly among the villages themselves, and the other half goes toward the maintenance of the WMA (including ranger salaries, for instance). The income received by villages can go toward a variety of causes, determined by CBO's: the construction of schools, health centers, and other infrastructure, aid for particularly vulnerable families, etc. (Sulle, Lekaita, & Nelson, 2011).

While in theory villages enjoy significant autonomy and control in the WMA process, problems arise at all stages. Although officially villages themselves initiate and have to agree to form part of a WMA, there have been examples of coercion and manipulation on the part of government

officials. For instance, Mayoka, one of the villages comprising Burunge WMA in northern Tanzania, had had disputes since 1984 with the authorities of Lake Manyara National Park, who stated that some land claimed by the village actually fell inside the park and thus prevented villagers from using it (Moyo, Ijumba, & Lund, 2016); as such, Mayoka residents viewed efforts to include it into a WMA suspiciously as an attempt to remove its land. Another village to be included in Burunge WMA, Minjingu, had already received revenue from tourist activities before the WMA was established, and joining the WMA would actually reduce this income. As such, it entered into legal conflicts with other villages, as it refused to recognize its own membership (Moyo et al., 2016). The division of revenue among villages is actually a common issue of contention, as villages may set aside differing amounts of land and/or contribute different amounts of effort to the maintenance of the WMA (Moyo et al., 2016). Yet another issue in Burunge concerned the lack of consent by a minority pastoralist group, the Barabaig, in the WMA designation, resulting in the forced restriction of access to their traditional grazing land; here, it becomes apparent that the seemingly ubiquitous farmer-pastoralist disputes also occur in, and are reflected by, WMA arrangements (Sulle et al., 2011).

A significant structural challenge that WMA's face is a lack of income transparency. WMA's forgo income they could receive from farming or grazing on now protected land, and income from tourist activities typically cannot compensate for this adequately, at least in the short run. Furthermore, the central government itself suffers from a lack of transparency, and since it controls disbursement of revenue, villages have often received less than their due share (even though their due share they receive is not particularly high, given the revenue distribution described above) (WWF, 2014). Another problem villages experience in relation to WMA's consists of attacks by wildlife on their crops, livestock, or occasionally even their very inhabitants. WMA legislation specifically precludes mandatory compensation for such losses, and while payments in the form of consolation are permitted and sometimes made to victims, these are not consistent and do not typically make up for the financial loss (Moyo et al., 2016).

## BENEFITS OF WMA'S

Wildlife Management Areas do provide benefits that should not be overlooked. First, they can generate some degree of income, and many member villages have actually made significant investments with it, such as the construction of new schools and dispensaries (WWF, 2014). Although many villages already benefitted from private tourist activities since the liberalization of tourism in Tanzania in the early 1990's, in other cases WMA's have introduced it to villages, which can bring a range of benefits, including even increased handicraft-making opportunities for women who can sell handicrafts to tourists (United Nations Development Program, 2015). Furthermore, WMA's can

provide employment to local inhabitants as village game scouts. In one WMA, Enduimet, located in primarily Maasai territory, legislation allows pastoralists to graze their cattle on reserved land, an unusual arrangement that benefits both pastoralist and tourist activity (Sulle et al., 2011). Promotional materials for WMA's, such as USAID reports, even emphasize how gender relations have improved as a result of WMA's, with a more equitable distribution of revenue among villagers and female participation in WMA decision-making boards. Finally, the impact on wildlife has largely been positive, with increases in many species populations and increased mobility (which has, ironically, led to issues for villagers themselves, as some animals may be destructive to life and property) (WWF, 2014).

## REDISTRIBUTION OF DECISION-MAKING POWER

Promotional materials about WMA's often try to portray them as "win-win" situations, citing participants' accounts that poaching is eliminated and villages enjoy inflows of resources. While most likely not fabricated, stories like these fail to acknowledge the often fraught political environment that WMA's can create or exacerbate, and they largely do not discuss how a village's situation may have worsened after a WMA was established (although, to their credit, such materials do consistently recognize that incomes are lower than expected). One particularly glaring omission is the change in the status of Game Controlled Areas (GCA's), a type of protected area. Before the establishment of WMA infrastructure, GCA's actually permitted all types of land use and settlement within their boundaries (forbidding only unlicensed hunting of wildlife); however, legislation on the foundation of WMA's changed this, prohibiting all agricultural and pastoral activity within GCA's (Sulle et al., 2011), thus functionally enclosing this land and removing its original users.

Ultimately, it is difficult to say that WMA's have significantly changed the power relations between local inhabitants, the centralized government, and outside companies and organizations. It is true that there is now a legislative template allowing villages to organize, which can provide them better negotiating power. However, as stated earlier, the national government (through the Wildlife Division) controls disbursement of payments, and these are not as transparent as desirable, although there is movement toward more direct control (WWF, 2014). Additionally, as many promotional materials themselves recognize, in negotiations with private investors, villagers often do not have the knowledge necessary to make informed and strategic decisions, allowing the company to take advantage of the village (WWF, 2014). The role of NGO's and international development agencies also merits discussion: as large and often well-financed players in African wildlife conservation and development projects, they provide a great deal of funding and thus have significant influence over the process. A report by Equator Initiative (a UNDP

partnership with vulnerable communities) attributes the initiative for the MBOMIPA project, a pilot project for one of the first WMA's in Tanzania, to the United Kingdom's Department for International Development, claiming that this project ultimately resulted in the legislation creating WMA's (the 1998 Wildlife Policy of Tanzania) (United Nations Development Program, 2015).

## CONCLUSION

Barrow and Murphree state that, in many cases of community conservation initiatives, planners and policymakers view participation "in an instrumental sense: as a means to achieve goals but not as a goal in its own right" (2001, p. 28). This description characterizes Tanzanian Wildlife Management Areas well. Tanzania's WMA's are an example of the attempted combination of conservation and development within the neoliberal conservation paradigm, which had already been introduced into Tanzania in the 1980's and 1990's; however, conservation goals dominate, and a rigid institutional structure reduces the opportunities that WMA's could provide. It can be argued that prioritizing conservation over development is not inherently unjust, but it can be ineffective if it does not successfully incentivize communities. Furthermore, local residents have benefitted from new economic opportunities in some communities but not in others, and the division of resources and revenue has caused disputes in some situations. It could logically be argued that the national government has in some situations actually extended its reach, as it now controls revenue from federally-registered WMA's. Of course, the case of Tanzania, while exemplifying several issues encountered in CBC in other areas (such as limited devolution of control), is not necessarily representative of all African countries, as contexts and outcomes have varied drastically. There is a growing movement advocating again for a renewed "fortress conservation" approach, criticizing CBC projects for their perceived lack of success in various regards (Jones, 2006). Such arguments, while based on fair criticisms, are premature: a current failure of CBC approaches to fairly involve communities does not necessarily mean that community involvement as a goal ought to be abandoned, as it is, still, a worthy goal.

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# Should Fingerprint Examiners Make More Erroneous Identifications?

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## ABSTRACT

This study was conducted as a response to the concerns about the consequences of latent fingerprint examinations. The goal is to determine if society's moral values align with the current bias towards erroneous exclusion decisions over erroneous identification decisions found in latent print examinations. Subjects of this experiment were asked to manipulate a web-based visualization that reflects the tradeoffs between putting guilty people in jail and keeping innocent people out of jail. The results of the experiment were analyzed to determine the similarities and differences between the opinions of fingerprint examiners and the opinions of students and members of the general public. In practice, examiners adopt more conservative decision criteria, because they could lose their job if they put an innocent person in jail. According to the results of this study, examiners seem to have a much more liberal exclusion criterion than they actually do in casework, and the public seems willing to tolerate a higher amount of erroneous identifications in exchange for a lower erroneous exclusion rate based on their average criteria placement in the visualization. The results of this study will help examiners align their responses to those of society, and help all citizens understand the tradeoffs that can occur with shifting decision criteria. If the results of the study indicate the need to shift the decision criteria to put more criminals in jail, additional safeguards may be necessary to guard against innocent people going to jail. Thus this dataset represents a rich framework for measuring, interpreting, and responding to the values and beliefs of what constitutes a just and moral society.

**KEYWORDS:** fingerprint decisions, taboo tradeoff, signal detection theory, society, criminal justice

## INTRODUCTION

This study was conducted as a response to the concerns about the accuracy of latent fingerprint examinations. During normal casework, fingerprint examiners compare latent fingerprints that come from a crime scene and typically have a fair amount of noise, and exemplar prints which are taken in a controlled environment and are typically higher quality than the latent prints. There are two types of fingerprint pairs an examiner can compare: mated fingerprints and non-mated fingerprints. Mated fingerprints are pairs of latent and exemplar fingerprints that actually came from the same finger, and non-mated fingerprints are pairs of latent and exemplar fingerprints that actually came from different fingers. The status of a pair of fingerprints is rarely known for certain outside of an experimental context. Instead, the examiner must make a conclusion that represents his or her opinion of the status of the prints. To do this, an examiner conducts an analysis and comparison of the two prints to make one of three decisions about a pair of fingerprints: identification, exclusion, or inconclusive. An identification decision means that the examiner believes there is enough perceived detail in agreement between two fingerprints to say the fingerprints came from the same finger. An exclusion decision means that the examiner believes there is either not enough detail in agreement or that there are sufficient details in disagreement between the two fingerprints to say they did not come from the same finger. An inconclusive decision means the examiner believes

there is not sufficient detail in agreement or disagreement to make an identification or exclusion decision.

In 2011, Ulery, Hicklin, Buscaglia, and Roberts measured the accuracy and reliability of latent fingerprint examiner's decisions in a study where 169 latent print examiners each compared around 100 pairs of latent and exemplar fingerprints from a pool of 744 pairs. Five examiners made erroneous identification decisions for an overall erroneous identification rate of 0.1%. Eighty-five percent of examiners made at least one erroneous exclusion decision for an overall erroneous exclusion rate of 7.5%. Further, 31.1% of the total mated fingerprints were classified as inconclusive and 11.1% of the non-mated fingerprints were classified as inconclusive (Ulery, Hicklin, Buscaglia, & Roberts, 2011).

This study brought to attention the current error bias in latent fingerprint examinations where examiners are more likely to make an erroneous exclusion decision—i.e. concluding that the fingerprints do not match when in reality they do—over an erroneous identification decision—i.e. concluding that the fingerprints do match when in reality they do not. This bias may be present for several reasons. It is possible that society has placed more importance on making sure innocent people are not put in jail, which would pressure the examiners into making more erroneous exclusion decisions over erroneous identification decisions. There is also the possibility that examiners fall back on inconclusive decisions in order to prevent making career-ending errors. Of course, if examiners say inconclusive all

the time then no crimes will be solved. This leads to a set of tradeoffs that occur when examiners must decide where to place their decision criteria, which then determines how much evidence is required before making an exclusion or identification conclusion. However, it is up to the individual examiner where to place their decision criteria, which could be a function of several different and possibly competing factors. For example, in addition to considering the amount of perceived detail in agreement between the two prints, the examiner might consider the rarity of this information, the likelihood of the detective bringing a mated print, the costs to society of various errors, and the personal consequences to the examiner of these errors. While the error bias found by Ulery et al. reflects how examiners translate their own moral values and personal tradeoffs into the decision criteria, it may not accurately reflect the values that the whole of society holds. This is compounded by the fact that the consequences of changing the decision criteria will typically have both positive and negative outcomes. In the case of making an identification decision, if an examiner requires less detail in agreement before making an identification, they could potentially contribute information that will increase the number of criminals in jail, but it would also increase the number of innocent people in jail. Moving the decision criterion in the opposite direction would help keep more innocent people out of jail, but could also let more criminals free. Because this tradeoff involves negative consequences regardless of the direction, it is known as a Taboo Tradeoff (Fiske & Tetlock, 1997).

A taboo tradeoff is defined by Alan Fiske and Philip Tetlock as a, “mental comparison or social transaction that violates deeply-held normative intuitions about the integrity, even sanctity, of certain forms of relationships and of the moral-political values that derive from those relationships” (Fiske & Tetlock, 1997, p. 256). Relational theory proposes four different models that support social relationships and decisions: communal sharing, authority ranking, equality matching, and market pricing. Each model has implementation rules decided by different cultures that provide guidance for how to compare actions, values, objects, and relationships within those models. However, there is no central model that determines how to make choices between the four relational models. This means that when it is necessary to weigh alternatives and choose between one of the four, there is no clear-cut way to make the necessary tradeoffs.

Fiske and Tetlock propose that a tradeoff is considered taboo when the entities being compared do not belong to the same relational models. For example, while the market-pricing model provides a way to think of socially meaningful relationships such as prices, rent, or wages, the communal sharing model provides a framework to think about relationships that are considered shared, such as shared goods or romantic relationships. Now imagine that someone asks you to assign a market pricing relation to an entity that is normally considered something that

belongs to the communal sharing model. The task could be something like, “How much money would you pay to breathe x-amount of air for a week?” or “How much money is your marriage worth?” Both of these questions seem very strange or even offensive. This is the idea of a taboo tradeoff. We believe that asking people to explicitly state their values when it comes to incarceration and exoneration is a taboo tradeoff and might cause discomfort among participants, because the prospect of putting an innocent person in jail violates the principles of freedom that form the basis of our society, yet sometimes it may be necessary to ensure an overall functioning society that places limits on crime. However, there is no easy solution, because it depends on the importance that one places on avoiding unjust incarceration, as well as maintaining justice for those affected by crime. Thus, an individual’s solution to the taboo tradeoff reflects his or her own attempt to resolve the tradeoff in a way that optimizes the outcomes that fit his or her personal values.

The goal of the present experiment is to measure the values of the different outcomes of latent print examinations when subjects are given a graphical representation of this taboo tradeoff. We might find that the general public is less concerned with innocent people being put in jail and may not tolerate the large percentage of inconclusive decisions found by Ulery et al. To do this, we created a web-based visualization that was based on the findings in the Ulery et al. study that subjects were told to manipulate depending on their own personal values. To generate this visualization, we analyzed the Ulery et al. data using a model known as signal detection theory (Macmillan & Creelman, 2004) as described next, which allows us to quantify the exact nature of the taboo tradeoff.

### *Modeling the Taboo Tradeoff with Signal Detection Theory*

To understand the importance of modeling the tradeoffs that can occur in forensic decision making, consider the following example from the related field of TSA baggage screening. As bags are scanned in the x-ray machine, the operator is compiling evidence that the bag contains a suspicious object. If so, the operator will ask to hand-search the bag, which causes a slow-down of the line and takes more personnel. However, if the suspicious object is allowed to pass, it could be used to hijack a plane. In addition, there are various factors that affect the decision to pull a bag for additional screening, such as the possibility of an imminent threat. In this case, the operator would adjust their criteria so that bags with even remotely suspicious items would get pulled for additional screening. This would result in many more false alarms and angry passengers, but it might be justified by the circumstances. All of these factors illustrate that the operator’s choice of decision criteria (in this case how suspicious an item looks before pulling the bag for additional screening) affects both the probability of stopping a terrorist attack as well as the number of bags that are screened that turn out to be fine.

The costs of each outcome in the above example are

fairly clear—we can calculate the additional cost of time and personnel of a false alarm, and we can estimate the cost of a terrorist attack. Note, however, that there is no way for the operator to simultaneously reduce the false alarm rate and reduce the chance of a terrorist attack. This is only possible through some additional scanning technology that specifically identifies suspicious objects either through some new form of x-ray or digital image processing.

When a similar analysis is applied to fingerprint examinations, we have additional constraints. First, the cost of a false alarm is much larger: an innocent person might go to jail, the real suspect may commit more crimes, and the examiner may be disciplined or fired if the error is discovered. Second, although a missed identification is not as bad as a terrorist attack, it

still may lead to a guilty person going free and committing more crimes. The same tradeoff still exists as with the TSA screener—the examiner may want to adjust their criteria to make more identifications, which will put more criminals and more innocent people in jail. However, this is not necessarily a 1:1 ratio. Depending on the exact nature of the tradeoff, we might find that for every one innocent person in jail, we put an additional 50 criminals in jail. We as a society might feel that this is a justifiable tradeoff, because the only way to never have an innocent person in jail is to never put anyone in jail. The problem is that the tradeoff is quite complex and the ratio will differ for different decision criteria. We used the data from Ulery et al (2011) to construct a model using signal detection theory that allows us to present this tradeoff to our subjects as

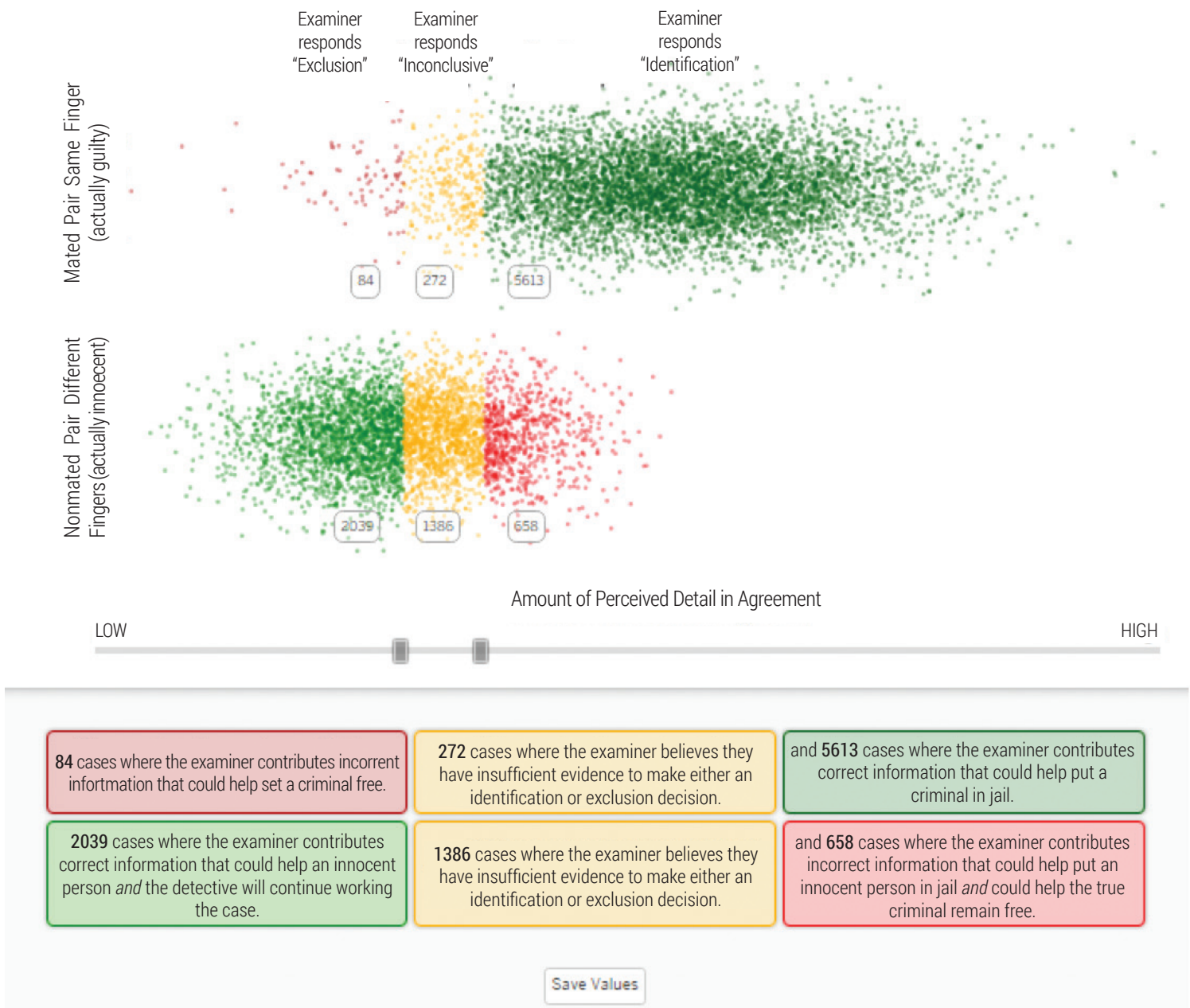


Figure 1: High nMated Web-based Model (Part 1)



Figure 1: High nMated Web-based Model (Part 2)

a graphical representation.

In order to estimate the tradeoffs that occur for the different outcomes (i.e. innocent people in jail vs. guilty people in jail) as an examiner adopts different decision criteria, we constructed a mathematical representation of the underlying distributions of mated and non-mated fingerprint pairs. We assume that a fingerprint comparison results in an *amount of perceived detail in agreement* which creates an evidence axis that examiners use to make decisions. Higher values along this unidimensional evidence axis are more likely to produce an identification decision and lower values are more likely to produce an exclusion decision.

In reality, an image pair is either mated or non-mated. The goal of the examination is to determine which conclusion is best supported by the evidence. Signal detection theory

allows us to estimate the mated fingerprint distribution and the non-mated fingerprint distribution using Gaussian curves, where the non-mated distribution is fixed with a mean of zero and a standard deviation of 1.0. This sets the scale of the evidence axis. We then adjust four free parameters: the location of the mated distribution, the standard deviation of the mated distribution, and the two decision criteria (one that separates exclusion from inconclusive responses and the other that separates inconclusive from identification responses). These parameters are fitted using minimization procedures (maximum likelihood estimation) to find parameter values such that the predicted proportions of different responses are as close as possible to the obtained proportions of responses. So, by using signal detection theory, we created a mathematical model that accurately predicts the proportions of examiner's decisions based on the actual



Figure 2

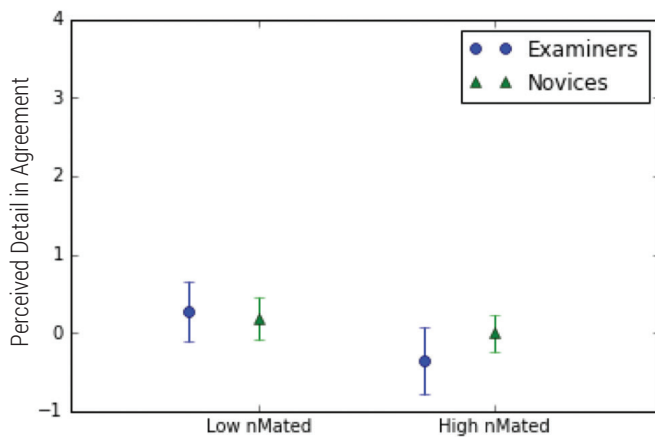


Figure 3: Exclusion Criterion Placement. All error bars in this figure and following figures are a 95% confidence interval based on the standard error of the mean multiplied by 1.96.

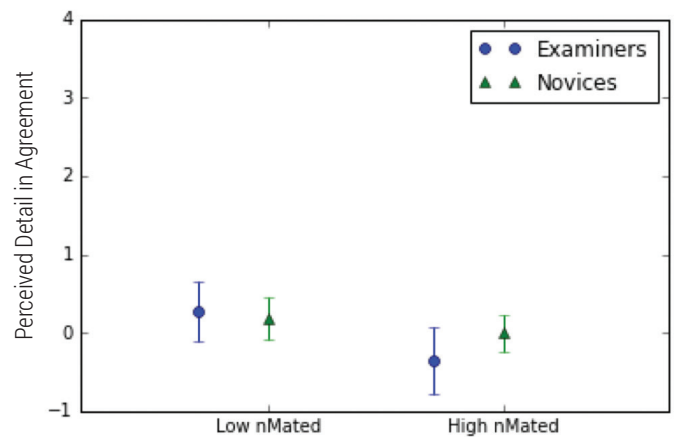


Figure 4: Identification Criterion Placement

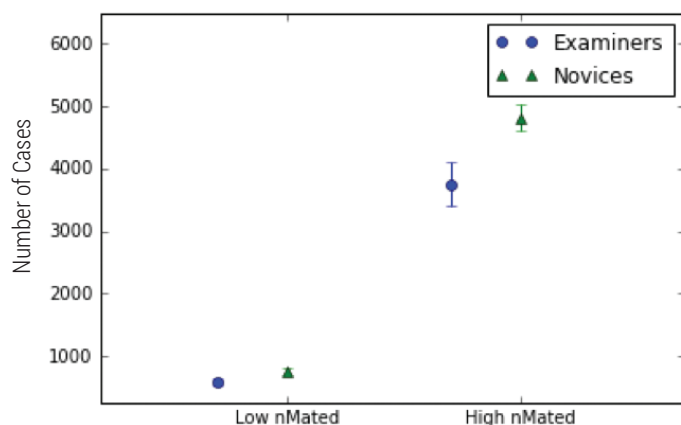


Figure 5: Average number of Criminals in Jail

proportions of decisions obtained from the Ulery et al. data. Table 1 illustrates the response proportions from the Ulery et al. data, and Table 2 illustrates the predicted proportions from signal detection theory. The best fitting parameters are: mated mean=3.42, mated standard deviation=1.54, exclusion criterion=1.21, and identification criterion=2.97. This means that the mated distribution is slightly more spread out than the non-mated distribution, and that examiners have adopted an extremely conservative decision criterion for the identification criterion, given that it is almost 3 standard deviations away from the center of the non-mated distribution.

The parameters that were freely estimated allow us to build a complete model of the tradeoffs that occur at various decision criteria. For example, if examiners were to adjust the identification criterion to the left, say adopting a value of 2.5 instead of 2.97 along the evidence axis, we know that both the number of criminals in jail would increase and the number of innocent people in jail would increase. However,

they would not increase by the same amount, or even proportionately as shown by the predictions of our model. Instead, we can determine the amounts that each would increase by asking how much more area under the non-mated and mated distributions falls to the right of the new location of the identification criterion. Figure 1 illustrates this using a graphical interface, and shows the data for two different decision criteria locations along with the consequences for each criterion.

The ability to directly compute the consequences of different decision criteria allows us to quantify the taboo tradeoff in such a way that we can explore the values expressed by different participants. For example, if a subject is uncomfortable with a certain number of innocent people in jail, they can shift the decision criteria to higher values along the evidence axis. However, this will simultaneously affect the number of criminals in jail, which will drop by an amount determined by the mathematical model. The visualization provides both a graphical representation of the two distributions and immediate feedback for the consequences of different decision criterion choices.

## METHODOLOGY

### Participants

A total of 222 subjects participated in this experiment. The subjects were split into two types: examiners and novices. There were 147 novice subjects who were undergraduate students attending Indiana University and were recruited from the Psychological and Brain Sciences Course Credit Subject Pool. These subjects were tested in a lab to ensure that they understood the background and importance of this task before participating and received course credit as compensation. The 75 examiner subjects that participated in this study were recruited from numerous conferences. These subjects accessed the experiment through a web-link and performed

Table 2: Proportion predictions made by the signal detection theory model

Pair Type	Exclusion	Inconclusive	Individualization	Total Mates or non-mates
<b>Mates (matches)</b>	0.075	0.311	0.614	1
<b>Non-mates (non-matches)</b>	0.887	0.111	0.001	1

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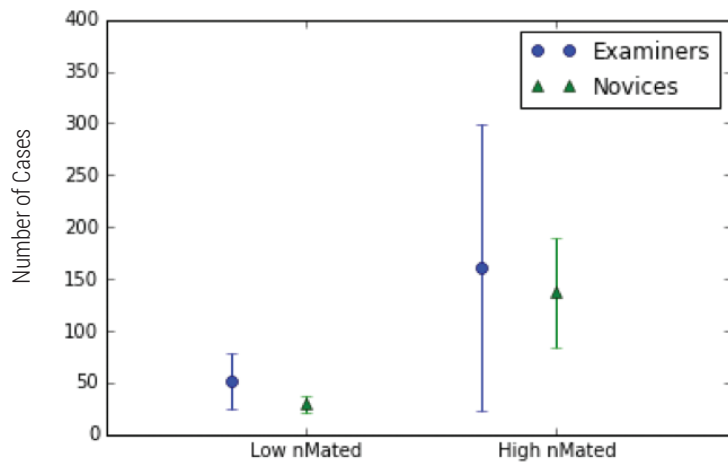


Figure 6: Average number of Criminals Set Free

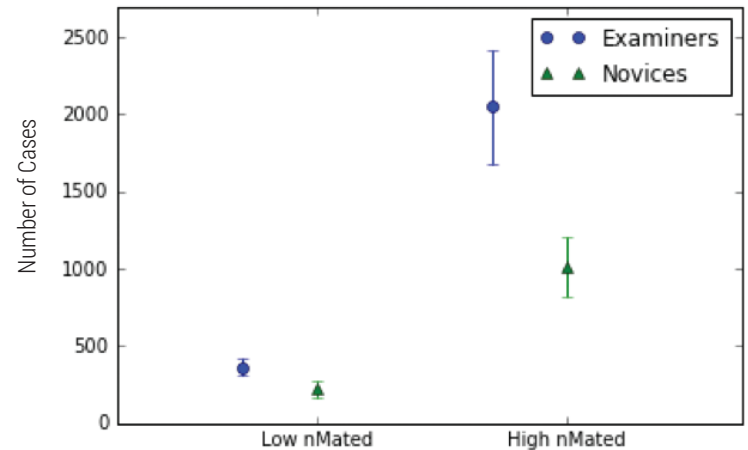


Figure 9: Average number of Inconclusive Decisions for Mated Pairs

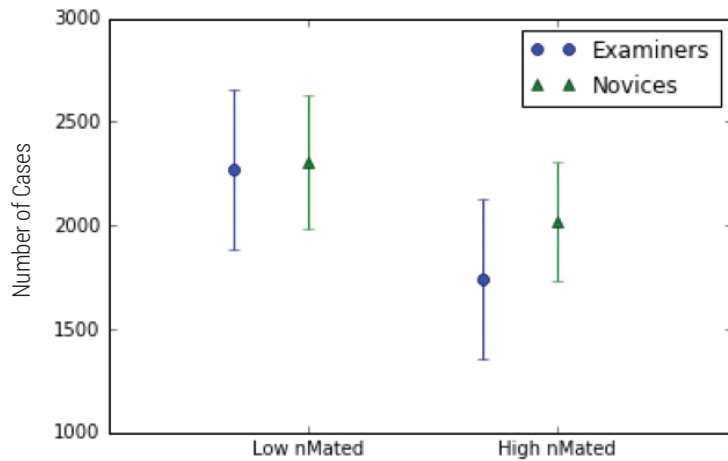


Figure 7: Average number of Innocents in Jail

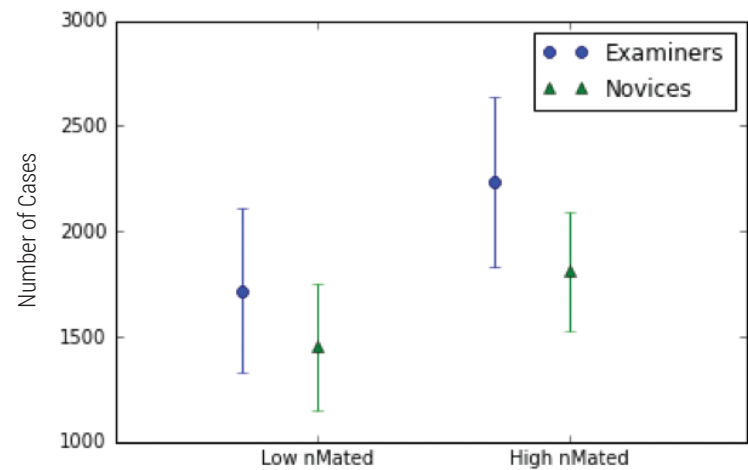


Figure 10: Average number of Inconclusive Decisions for Non-Mated Pairs

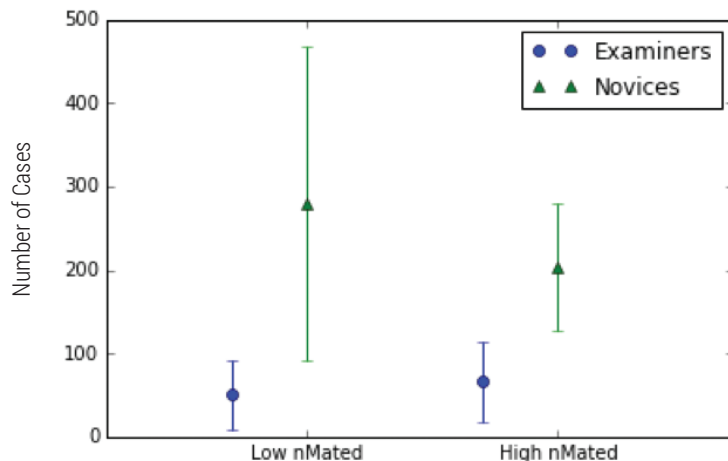


Figure 8: Average number of Innocents Set Free

the experiment on their own. All subjects watched a 6 minute instructional video before being directed to manipulate the web-based visualization (Figure 1). After saving their exclusion criterion and identification criterion placements, subjects were asked to fill out demographic data. Subjects that failed to fill out demographic data were discarded. The experiment took

approximately 15 minutes to finish.

### Procedure

Optimizations will include the improvements in the feed. The subjects were randomly assigned one of two web-based visualizations to manipulate. The only difference between the two visualizations was the number of mated fingerprints (nMated) represented in the top cloud: either the High nMated condition where nMated=5969 or the Low nMated condition where nMated=1000. The High nMated condition reflects the distributions found in the Ulery et al. data while the Low nMated condition was created to determine how great of an effect the actual numbers of cases shown in the visualization affected criteria placement. Figure 2 shows the model with the Low nMated condition. The top cloud in the figure represents pairs of mated fingerprints and the bottom cloud represents pairs of non-mated fingerprints. The x-axis represents the amount of perceived detail in agreement between the two fingerprints. The y-axis is an arbitrary axis that serves to separate the mated and non-mated groups. The first slider represents the exclusion criterion; everything to the left of this slider is an exclusion

decision and everything to the right is an inconclusive decision. The second slider represents the identification criterion; everything to the right of this slider is an identification decision and everything to the left is an inconclusive decision. The boxes below the clouds explain the outcomes of placing the sliders in a specific position and are color coordinated to indicate good outcomes (green), bad outcomes (red), and inconclusive outcomes (yellow). The colors of the clouds match the colors of the boxes in the same positions; for example, the green cloud in the upper right hand corner corresponds to the outcomes in the green box in the upper right hand corner. As the sliders are moved, the number of cases in each box changes proportionally. The subjects were instructed to carefully read all of the outcomes in each box and move the sliders to a position where they were comfortable with the outcomes in the boxes. After the subjects were comfortable with the position of the sliders, they clicked the "Save Values" button below the boxes and proceeded to fill out demographic data.

## RESULTS

Table 3 shows the mean criteria placement and standard deviation for the exclusion criterion for both the High nMated and Low nMated conditions for both subject types. Running a two-tailed, unpaired t-test comparing the exclusion criterion placement of High nMated examiners and High nMated novices shows that there is not significant difference at  $p < 0.05$  between exclusion criterion placement of the examiners (mean=-0.36) and novices (mean=-0.01) in the High nMated condition ( $t = -1.46$ ,  $p = 0.15$ ). The results of a two-tailed, unpaired t-test comparing the exclusion criterion placement of Low nMated examiners and Low nMated novices shows that there is not a

significant difference at  $p < 0.05$  between exclusion criterion placement of the examiners (mean=0.27) and novices (mean=0.18) in the Low nMated condition ( $t = 0.35$ ,  $p = 0.73$ ).

Table 4 shows the mean criteria placement and standard deviation for the identification criterion for both the High nMated and Low nMated conditions for both subject types. The novice subjects were broken down into two groups for this criterion: Random Novice and Fixed Novice. The Fixed Novice group was created because significant data collection occurred with a link for the web-based model that only provided the High nMated condition. The Random Novice group consists of the novices that were randomly assigned the High nMated condition. There is no significant difference between the mean identification criterion for each novice group ( $t = 0.0184$ ,  $p = 0.9854$ ). Because there was not a significant difference between the Fixed Novice group and the Random Novice group, the Fixed Novice data was not used in the creation of any other graphs or tables. The results of a two-tailed, unpaired t-test comparing the identification criterion placement of the High nMated examiners and the High nMated random novices shows that there is a significant difference at  $p < 0.01$  between the mean identification criterion placement of the examiners (mean=2.84) and the novices (mean=1.87) in the High nMated condition ( $t = 4.97$ ,  $p = 4.22e-6$ ). The results of a two-tailed, unpaired t-test comparing the identification criterion placement of the Low nMated examiners and the Low nMated novices shows that there is a significant difference at  $p < 0.01$  between the mean identification criterion placement of the examiners (mean=3.03) and the novices (mean=2.17,  $t = 3.92$ ,  $p = 1.91e-4$ ).

Figure 3 shows the average exclusion criterion placement for

Table 3: Exclusion Criterion Placement

Condition Type	Subject Type	Mean Criteria Placement	Standard Deviation	Sample Size
<b>High nMated</b>	Examiner	-0.36	1.29	35
	Novice	-0.01	0.77	41
<b>Low nMated</b>	Examiner	0.27	1.20	38
	Novice	0.18	0.84	40

Table 4: Identification Criterion Placement

Condition Type	Subject Type	Mean Criteria Placement	Standard Deviation	Sample Size
<b>High nMated</b>	Examiner	2.84	0.80	35
	Fixed Novice	1.87	1.26	68
	Random Novice	1.87	0.87	41
<b>Low nMated</b>	Examiner	3.03	0.82	38
	Novice	2.17	1.06	40



Figure 11: Average Examiner Placement of Exclusion and Identification Criteria according to the "Black Box" Study



Figure 12: Average Examiner Placement of Exclusion and Identification Criterion according to this study

both examiners and novices. The y-axis represents the perceived detail in agreement between two fingerprints and the x-axis represents the High nMated and Low nMated conditions. The values on the y-axis are equal to the standard deviation of the non-mated distribution, which is fixed at 1.0.

Figure 4 shows the average identification criterion placement for both examiners and novices. The y-axis represents the perceived detail in agreement between two fingerprints and the x-axis represents the High nMated and Low nMated conditions. The values on the y-axis are equal to the standard deviation of the non-mated distribution, which is fixed at 1.0.

Figures 5-10 illustrate the different outcomes of the cases that result from moving the decision criteria to different locations. Figure 5 shows the average amount of “Criminals in Jail” indicated by both examiners and novices for the High nMated and Low nMated conditions. Figure 6 shows the average amount of “Criminals Set Free” indicated by both examiners and novices for the High nMated and Low nMated conditions. Figure 7 shows the average amount of “Innocents in Jail” indicated by both examiners and novices for the High nMated and Low nMated conditions. Figure 8 shows the average amount of “Innocents Set Free” indicated by both examiners and novices for the High nMated and Low nMated conditions. Figure 9 shows the average amount of “Inconclusive Decisions for Mated Pairs” indicated by both examiners and novices for the High nMated and Low nMated conditions. Figure 10 shows the average amount of “Inconclusive Decisions for Non-Mated Pairs” indicated by both examiners and novices for the High nMated and Low nMated conditions.

Figure 11 shows the average placement of the identification and exclusion criteria of examiners found by Ulery et al. represented using the High nMated web-based visualization. Figure 12 comparatively shows the same distributions that were used in Figure 10 but instead uses the mean placement of the identification and exclusion criteria of the examiner subjects in this study. Figure 13 shows the same distribution used in both Figure 11 and Figure 10 but instead uses the average placement of the identification and exclusion criteria that the novice subjects indicated in this study.

## DISCUSSION

The results of this study seem to support the idea that the general public shows less of a bias toward erroneous exclusion decisions than examiners and are less tolerant of a large amount of inconclusive decisions. According to the results shown in Figure 3, there is a significant difference between the novice and examiner placement of the identification criterion. As shown in Table 2, the mean placement of the identification criterion by the novice subjects is lower than the examiner subjects for both the High nMated and Low nMated conditions. This suggests that the novice subjects are more willing to accept an erroneous identification decision in exchange for fewer inconclusive decisions.

This finding can also be seen looking at the different placements of the exclusion and identification criteria in Figures 11, 12, and 13. Figure 11 represents the average criteria

placement of the examiners found in the Ulery et al. study. In this figure, the identification criterion is located at 2.97 along the evidence axis and the exclusion criterion is located at 1.21. The placement of these criteria represents how examiners are actually classifying prints during casework. Figure 12 however represents the examiner's average criteria placement found in this study. It is interesting to note that while the identification criterion is relatively close to the placement in Figure 11, the exclusion criterion is placed significantly lower than in Figure 11. This indicates that while examiners place their criteria in one place during casework, ideally examiners would rather increase the amount of inconclusive decisions in order to decrease the amount of erroneous exclusion decisions. On the other hand, by looking at Figure 13 we can see that the novice subjects placed their exclusion criterion relatively close to the examiner's exclusion criterion in Figure 12. However, while the novices and examiners had fairly similar placement of the exclusion criterion, the novice subjects placed their identification criterion significantly lower than the examiners. This indicates that novices would rather allow more erroneous identification decisions in exchange for fewer inconclusive decisions and are comfortable with having more erroneous exclusion decisions than examiners currently allow in casework.

The difference in criterion placement between the two groups may indicate that the decisions of examiners in latent print examinations do not accurately reflect the values of society. Currently, there is a bias towards erroneous exclusion decisions in examinations. It is seen as a much worse mistake to accidentally incarcerate an innocent person than to accidentally exonerate criminals, in fact if an examiner does commit an erroneous identification decision there is a possibility of losing his or her job. This pressure may be what is causing this erroneous exclusion bias. However, according to the results of this study, perhaps society would actually be more comfortable increasing the amount of erroneous identification decisions in exchange for less erroneous exclusion decisions.

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Juan is originally from Evansville, Indiana, and is a senior at IU majoring in International Studies. Having a broad range of interests, over his time at IU he has studied a few foreign languages and become increasingly interested in sustainability and international sustainable development. He has done research in IU's Center for the Analysis of Social-Ecological Landscapes for over two years, and would like to do research and/or NGO work upon graduation.

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Willa Mannering is a junior at IU majoring in Cognitive Science and Computer Science with a minor in Philosophy of Mind. She is doing research with Dr. Thomas Busey and Dr. Robert Goldstone. Her research with Dr. Busey consists of looking at society's values when it comes to latent fingerprint examinations, and her research with Dr. Goldstone has to do with how images are categorized and stored. After receiving her Bachelor's degree, she plans to go to graduate school and work towards a career doing research, whether that be in industry or academia.

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Jordan is a junior pursuing a Bachelor of Arts in Journalism. She has been passionate about media research, specifically media's effect on human behavior since her freshman year. She has been working on this study since then with her faculty mentor Dr. Jessica Myrick and Ph.D student Rachelle Pavelko. Besides media research, Jordan is passionate about writing, Netflix, and traveling. After she graduates in December 2017, she hopes to pursue her masters abroad in Ireland or Scotland.

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# ABOUT THE AUTHORS

## RICHARD SOLOMON



Richard is a Wells Scholar with majors in International Studies, Near Eastern Languages and Cultures, and a Political Science and Philosophy interdepartmental. He's a member of the Arabic Flagship Program and treasurer for Students for Peace in the Middle East. He participates in Model UN, having represented IU at the 2016 National MUN Conference and directed committees for the 2016 and 2017 IUMUNC conferences. He works for the Office of International Development and broadcasts a weekly philosophy program for the WIUX student radio on 99.1FM. His past research experience includes foreign investment law with Professor Bauerle-Danzman, nuclear proliferation with Professor Dina Spechler, and Israeli settlements in the Palestinian territories at the Applied Research Institute-Jerusalem. In the IU Student Association, he has served two years as Election Commissioner and will graduate with two years on the Supreme Court.

## DAMON PHAM



Damon is a freshman studying statistics at Indiana University–Bloomington. Originally from Fremont, California, he spent this past summer exploring large datasets which concern intracellular regulatory systems—in other words, a sublime “kosmos,” only within a different dimension—at the Ma’ayan Laboratory of the Icahn School of Medicine at Mount Sinai.

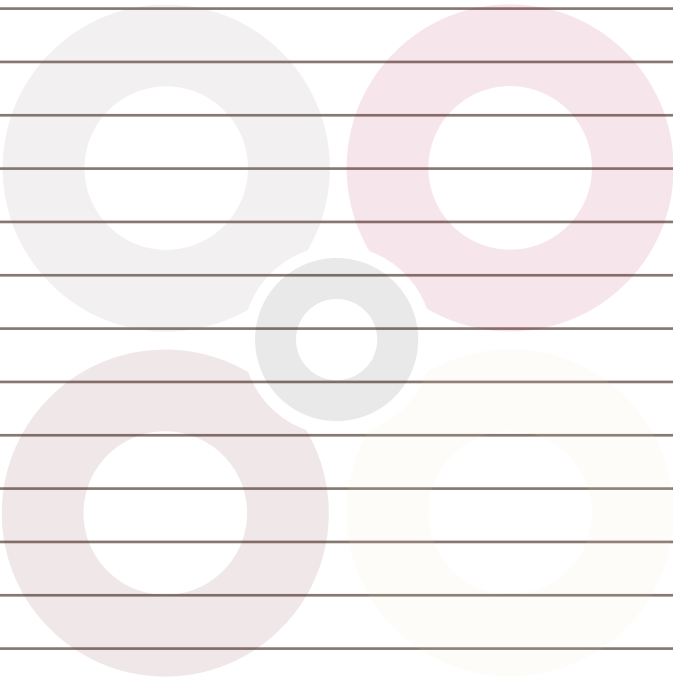
## NOAH SCHLOSSBERGER



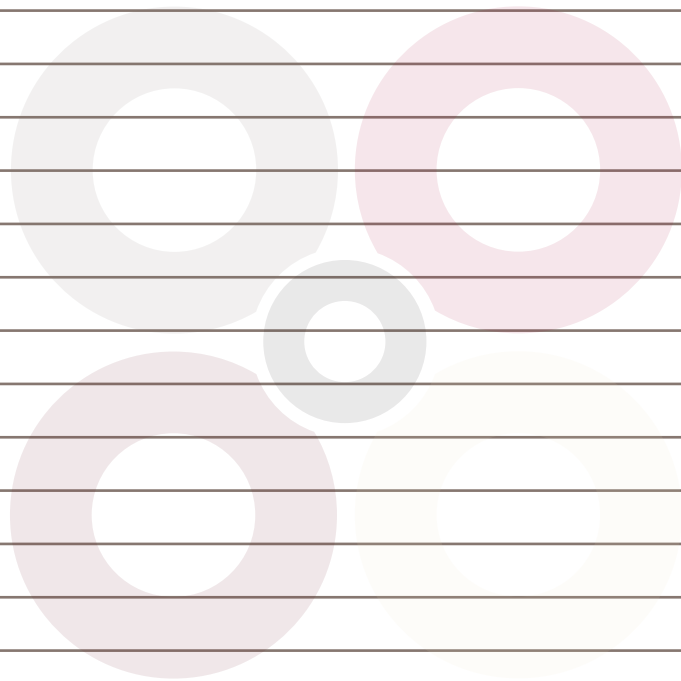
Noah is a sophomore studying physics and mathematics with a certificate in audio electronics at Indiana University Bloomington. He has also studied computer science at Stanford University. He currently works under Dr. Phil Richermeon constructing hardware components of an ion trap and control instrumentation for 2-D quantum simulation. After graduation, Noah plans to pursue graduate study to continue exploring quantum computation and information.



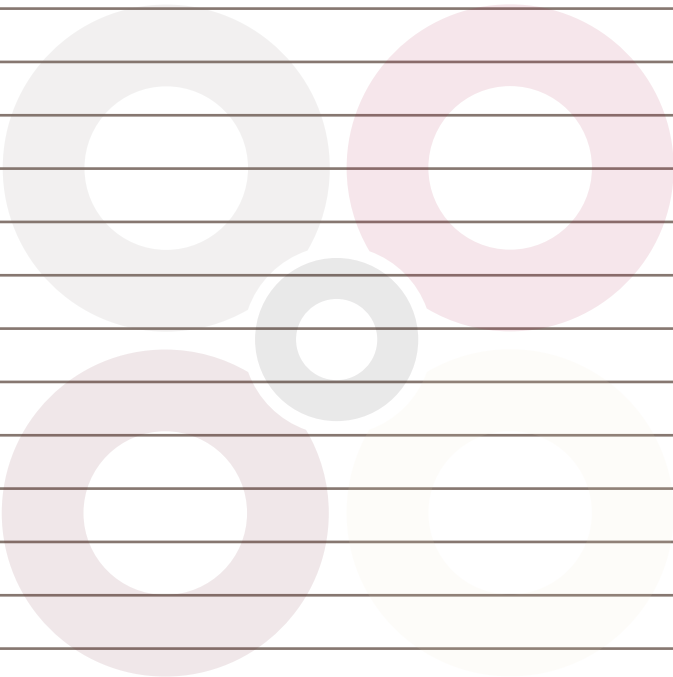
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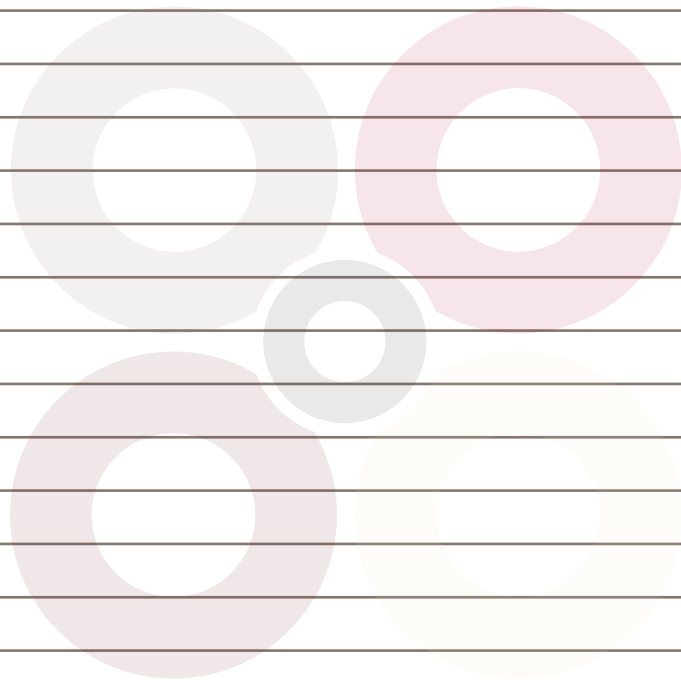
# Notes



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Indiana University Journal of Undergraduate Research  
Vol. III (2017)