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Evolution of Muir glacier (August 1941-August 2004), Glacier Bay National Park, Alaska

Aly, Amaral, Araujo, Bowen, Castellarin, Castillo, Clark, Cryan, DeCastro, Field, Gardiner, Guillette, Mahoney, Manton, McGuire, Nevius, Prince, Ridlen, Sanchez, Snow, Spicer, Sun, Turpin, Uboldi, West, Zheng

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On the Cover:
"Muir Glacier Pair." Image Credit: National Snow and Ice Data Center, W. O. Field, B. F. Molnia

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Deriving the Dyer-Roeder Equation from the Geodesic Deviation Equation via the Newman-Penrose Null Tetrad

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The Dyer-Roeder equation is an equation used for calculating distances to astronomical objects. The Dyer-Roeder equation approximates the universe to have a uniform density in all directions, i.e. that the universe is homogeneous and isotropic [Foster et al (1995)]. The metric used to derive the equation assumes there are no clumps of matter in the space-time, which makes the equation for distance simple enough to derive. The assumption that the universe has a uniform density limits the scope of objects to which we can calculate the distance. If light from an astronomical object on its way to earth, passes through the gravitational field of a clump of matter then we cannot calculate the distance to that object using Dyer-Roeder equation.

Attempts to find a solvable expression for angular diameter distance using a metric that allows for clumps of matter have historically been unfruitful. We think this failure is a direct result of using basis vectors that are best suited to deal with flat space-times rather than curved space-times. In this paper we attempt to show that the N-P null-tetrad of basis vectors is better suited for the curvature of space-time associated with clumpy cosmologies.

The N-P formalism for General Relativity is useful in dealing with motion of light-bundles, or a propagating pencil of light rays, in a curved space-time. It allows us to deal with problems arising from the curvature of space-time due to local variations in matter density by introducing the null tetrad of basis vectors. In the phrase "null-tetrad", the word "null" means light-like and "tetrad" means a set of four. The reason we need four vectors is due to the fact the we are working in a four dimensional space-time which requires four independent bases vector to span the whole space. Since astronomers study astronomical objects by observing light emitted from these objects, it makes sense that we would use the null-tetrad of basis vectors when deriving an equation for the distance to these objects. Before this can be accomplished we should be able to show that the N-P null-tetrad can produce the equation for angular diameter distance for a flat FLRW. Once this is shown to be the case we can calculate angular diameter distance for the perturbed FLRW.

This derivation of the Dyer-Roeder equation is a first step in obtaining an equation for angular diameter distance in a perturbed FLRW metric using the N-P terad. We start our derivation with a discussion about the null tetrad. We then use the flat FLRW metric to calculate the N-P components needed to solve the geodesic deviation equation for angular diameter distance. Finally we make the

appropriate substitutions to get the Dyer-Roeder equation.

Mathematical Background
The General FLRW Metric

The most general form of the FLRW, as discussed in section 1, allows for global curvature. The metric can be expressed to account for all three possible global curvatures in a homogeneous and isotropic universe.

$$ds^2 = dt^2 - a^2(t) \begin{cases} Closed: & d\psi^2 + \sin^2\psi\left(d\theta^2 + \sin^2\theta d\phi^2\right) \\ Flat: & dx^2 + dy^2 + dz^2 \\ Open: & d\psi^2 + \sinh^2\psi\left(d\theta^2 + \sin^2\theta d\phi^2\right) \end{cases}$$

(1)

The metric is expressed for the three possible geometries. The possible geometries arise from the EFE equation(2 ,[Carroll,S. (2004), p. ~332].

$$R_{ab} - \frac{1}{2} R g_{ab} = 8\pi T_{ab}$$

(2)

In the EFE the metric is expressed as a second rank tensor. T_{ab} is the stress tensor which codes the distribution of pressure, matter, and energy. R_{ab} and R are the Ricci tensor and scalar respectively (see section 1).

Using

$$T_{ab} = \rho u_a u_b + P(g_{ab} + u_a u_b)$$

(3)

,where u is a velocity four vector and ρ is the mass density of our dust model. In the flat case, the case in which we are interested, the metric can be be expressed in terms of the scale factor $(a(t))$, as:

$$ds^2 = dt^2 - a^2(t)(dx^2 + dy^2 + dz^2).$$ (4)

Null-Tetrad

For our derivation we will use the N-P formalism. This formalism makes use of a tetrad, or a set of four, basis vectors associated with a light ray. The null-tetrad is:

$$\lambda_i^a = \{l^a, n^a, m^a, \overline{m}^a\},$$

(5)

Where $l^a, n^a, m^a, \overline{m}^a$ is a set of four basis vectors. In our tetrad, l^a is tangent to the light ray, n^a is perpendicular to l^a in the metric space/plane. m^a and $\overline{m}^a$ are complex axial vectors for a cross section which slices an ellipsoid shaped bundle of light-rays (see figure 1). The proposed null-tetrad in terms of the parameter ξ and the cosmological scale factor $a(t)$, are:

$$l^a = \frac{1}{a(t)\sqrt{2}(1+\xi\overline{\xi})}\langle(-1-\xi\overline{\xi}),\frac{1}{a(t)}(\overline{\xi}+\xi),\frac{i}{a(t)}(\overline{\xi}-\xi),\frac{1}{a(t)}(-1+\xi\overline{\xi})\rangle,$$

(6)

$$n^a = \frac{a(t)}{\sqrt{2}(1+\xi\overline{\xi})}\langle(-1-\xi\overline{\xi}),\frac{-1}{a(t)}(\overline{\xi}+\xi),\frac{i}{a(t)}(\xi-\overline{\xi}),\frac{1}{a(t)}(-1+\xi\overline{\xi})\rangle,$$

(7)

$$m^a = \frac{1}{a(t)\sqrt{2}(1+\xi\overline{\xi})}\langle0,(1-\overline{\xi}^2),-i(\overline{\xi}^2+1),2\overline{\xi}\rangle,$$

(8)

$$\overline{m}^a = \frac{1}{a(t)\sqrt{2}(1+\xi\overline{\xi})}\langle0,(1-\xi^2),i(\xi^2+1),2\xi\rangle.$$

(9)
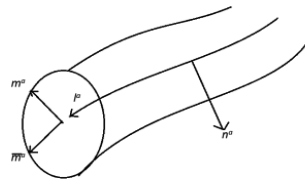
Figure 1: Shows an ellipsoid light-bundle traveling along the l^a direction. The tetrad are represented by the four arrows in the figure

This is the general expression for the N-P null-tetrad in Cartesian, x,y,z, coordinates. In equations (2.2), ξ & $\overline{\xi}$ are stereographic projections onto a complex plane. They map all points on a semi-

sphere onto a flat complex plane (see figure 2).

$$\xi = \cot\left(\frac{\theta}{2}\right)e^{i\phi}, \qquad (10)$$

where $0 < \theta < \pi \; and \; 0 \leq \phi \leq 2\pi$.

In this derivation we can make some assumptions about the space-time and the tetrad to make them simpler. Since Dyer-Roeder assumes a flat homogeneous and isotropic universe, in our derivation, we assume the same thing. If we are looking at an object that is directly overhead, the light from that object will not have components in the x-y plane (this amounts to choosing an origin for a coordinate system). The only direction along which the light ray should progress is the z-direction, using standard Cartesian coordinates (see figure 3).
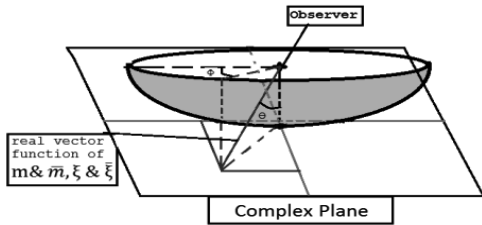
Figure 2: Shows an observer at the center of a semi-sphere of light. The semi-sphere of light ray-vectors $v = v(\xi, \bar{\xi}, m, \bar{m})$ is mapped onto a complex plane.
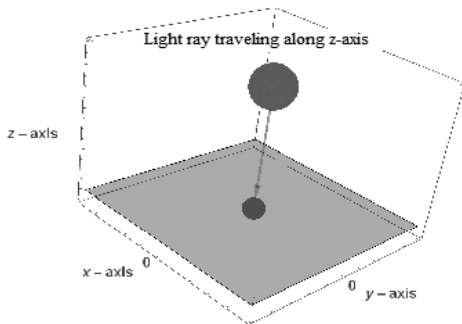
Figure 3: Shows a light emitting object directly over head. The light ray only travels in the z-direction.

The vector l^a is tangent to the light-ray, which means that $l^a = \frac{1}{\sqrt{2}}\langle \dot{t}, \dot{x}, \dot{y}, \dot{z} \rangle$ and since we have no movement in the x-y plane, $\dot{x} = 0$ and $\dot{y} = 0$. In terms of our stereographic coordinates, ξ and $\bar{\xi}$, the angle θ is measured from the center of a sphere with respect to the point at which the semi-sphere touches the plane (see figure 2). This strategic choice of coordinates makes the task of calculating distance easy by making $\xi = \bar{\xi} = 0$. Our null tetrad now has spatial components in only the z direction, and the time component remains unchanged.

$$l^a = \frac{1}{a(t)\sqrt{2}} \; \langle -1, 0, 0, \frac{-1}{a(t)} \rangle \; , \qquad (11)$$

And since $\xi = \bar{\xi} = 0$, m^a becomes:

$$m^a = \frac{1}{a(t)\sqrt{2}} \langle 0, 1, -i, 0 \rangle. \qquad (12)$$

Now that we have l^a and m^a we solve for the N-P components needed to solve the geodesic deviation equation. To find an expression for angular diameter "distance", or the equivalent of Dyer-Roeder equation, for a perturbed FLRW metric, we will need to use the tetrad in equations (2.2).

Note: n^a, m^a, and m^{-a} *all have components that are NOT tangent to the light-ray. We only make that argument for l^a and use* $\xi = \bar{\xi} = 0$ *to get the rest of the tetrad in the derivation that follows.*

Angular Diameter Distance in a Flat, Homogeneous, and Isotropic Universe
Angular Diameter Distance is a way to talk about the distance to faraway objects of known size.

Suppose there is a sphere of radius (l). When viewed by an observer from some distance (d), it subtends an angle θ as measured by the observer(see figure 4). If the angle is small enough, then the diameter is approximately equal to the arc length. The arc length is a product of the radius and the angle of the arc. Here the radius is the Angular Diameter-Distance (D_A).

$$D_A = \frac{l}{\theta} \qquad (13)$$

Astronomers use the angular diameter distance to estimate the distance to an object. This is done by measuring the angle subtended by an object of known size. If the angular diameter distance of the object is known, then its size can be estimated using the same relation.
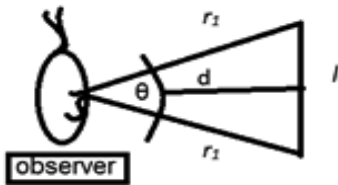
Figure 4: The angular diameter distance is related to the Luminosity Distance (d_L) by redshift (z_R) and comoving transverse distance (d_M) [Ryden, B. (2003)]:

$$d_L = d_M \left(1 + z_R\right) \qquad (14)$$

$$D_A = \frac{d_M}{1 + z_R}. \qquad (15)$$

The comoving transverse distance (d_M) is defined in terms of the proper transverse velocity (u) as measured using redshift. The velocity is calculated

using $u = \dfrac{c}{H_0} \dfrac{(1 - z_R)^2}{(1 + z_R)^2}$ and the angular velocity

($\dot{\theta}$) as measured relative to an observer [Carroll,S. (2004), pp.~344-349].

$$d_M = \frac{u}{\dot{\theta}} \qquad (16)$$

Due to the expansion of the universe with time, astronomers must consider the effects the expansion has on measurement and calculation. One of these effects is that in an expanding universe, a fixed, non-expanding, coordinate system will give different coordinates for objects which are at rest otherwise.

To deal with this difficulty we make use of a comoving coordinate system. This is a system of coordinates that expands at the same rate as that of the universe, allowing objects that move due to expansion only to keep the same coordinates. The actual distance is then obtained via a coordinate transformation. The comoving distance is then the separation distance between the source of the light and the observer in this expanding coordinate system. The comoving distance (transverse) between any two objects in this system is the separation distance between the two points. This comoving distance is not the actual distance one would travel if one wanted to get to the object in question. To get the actual distance we need to include the cosmic scaling factor which is a parameter with a magnitude that varies with time.

Note: this is only true for a Flat, homogenous, and Isotropic universe.

Derivation
Calculating the N-P Components for the Flat FLRW Metric Using the Tetrad
We start our derivation of the Dyer-Roeder equation from the geodesic deviation equation by

choosing a cosmology or a metric. The metric we use is the FLRW metric for a flat cosmology as discussed in section (2.1). This is an expanding cosmology that has a uniform matter density in every direction, and it is flat everywhere. We can express the flat FLRW metric in two important ways:

$$ds^2 = dt^2 - a^2(t)(dx^2 + dy^2 + dz^2) \qquad (17)$$

$$g_{ab} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -a^2(t) & 0 & 0 \\ 0 & 0 & -a^2(t) & 0 \\ 0 & 0 & 0 & -a^2(t) \end{bmatrix}, \qquad (18)$$

The N-P components, needed for the geodesics deviation equation, are:

$$\Phi_{00} = -\frac{1}{2}R_{ab}l^a l^b \qquad (19)$$

$$\Psi_0 = -C_{abcd}l^a m^b l^c m^d \qquad (20)$$

Where R_{ab} is the Ricci tensor and C_{abcd} is the Weyl tensor. These tensors encode the curvature of the space in question and they are calculated by contracting the Riemann tensor R^a_{bcd}. The Ricci tensor is the symmetric part of the Riemann tensor and it is expressed as:

$$R_{ab} = R^c_{acb}, \qquad (21)$$

where the Riemann tensor is contracted along the repeated index. The Weyl tensor is the curvature tensor "with all of its contractions removed", it is the anti-symmetric part of the Riemann tensor [Carroll,S. (2004)]. For a four dimensional manifold

the Weyl tensor is:

$$C_{abcd} = R_{abcd} - g_{a[c}R_{d]b} - g_{b[c}R_{d]a} + \frac{1}{3}g_{a[c}R_{d]b}. \qquad (22)$$

The Riemann tensor $R_{abcd} = g_{ae}R^e_{bcd}$ is defined in terms of the Levi-Civita connection Γ^a_{bc} as:

$$R^a_{bcd} = \partial_c\Gamma^a_{db} - \partial_d\Gamma^a_{cb} + \Gamma^a_{ce}\Gamma^e_{db} - \Gamma^a_{cb}. \qquad (23)$$

We can calculate the Levi-Civita Connection Γ^a_{bc} from the metric tensor, equation (1). The connection is defined to be:

$$\Gamma^a_{bc} = \frac{1}{2}g^{ad}(\partial_b g_{cd} + \partial_c g_{db} - \partial_d g_{bc}). \qquad (24)$$

We used the xAct package in Mathematica to find the components of the connection, Ricci, and Weyl tensors. The surviving connection terms are [Wald, R. M. (1984), p.~ 97]:

$$\Gamma^0_{ii} = a\dot{a} \qquad (25)$$

$$\Gamma^i_{0i} = \Gamma^i_{i0} = a\dot{a} \qquad (26)$$

for $i=1,2,3$. The Weyl tensor vanishes in a flat FLRW, or $C_{abcd} = 0$ in equation (20), and we are only left with the Ricci terms. The Ricci tensor has only the following components:

$$R_{00} = \frac{-3\ddot{a}}{a} \qquad (27)$$

and

$$R_{ii} = a\ddot{a} + 2\dot{a}^2, \qquad (28)$$

for $i=1, 2, 3$. Now that we have these components we can calculate Φ_{00} by substituting equations (1) into equation (19), or:

$$\Phi_{00} = \frac{-1}{2} R_{ab} l^a l^b = \frac{-1}{2} \left[R_0 l^0 l^0 + R_1 l^1 l^1 + R_2 l^2 l^2 + R_3 l^3 l^3 \right]$$

$$\Phi_{00} = \frac{-1}{2} \left[\frac{-3\ddot{a}}{a} (l^0)^2 + (a\ddot{a} + 2\dot{a}^2)(l^1)^2 + (a\ddot{a} + 2\dot{a}^2)(l^2)^2 + (a\ddot{a} + 2\dot{a}^2)(l^3)^2 \right]$$

Substituting in our tetrad:

$$\Phi_{00} = \frac{-1}{2} \left[\frac{-3\ddot{a}}{a}(\frac{1}{a^2 2}) + (a\ddot{a} + 2\dot{a}^2)(0) + (a\ddot{a} + 2\dot{a}^2)(0) + (a\ddot{a} + 2\dot{a}^2)(\frac{1}{a^4 2}) \right]$$

Then by removing the zero terms, distribution, and expansion we get,

$$\Phi_{00} = \frac{-1}{2} \left[(\frac{-3\ddot{a}}{2a^3}) + \frac{a\ddot{a}}{2a^4} + \frac{2\dot{a}^2}{2a^4} \right] = \frac{-1}{2a^2} \left[(\frac{-3\ddot{a}}{2a}) + \frac{\ddot{a}}{2a} + \frac{\dot{a}^2}{a^2} \right] = \frac{-1}{2a^2} \left[(\frac{\dot{a}}{a})^2 - \frac{\ddot{a}}{a} \right]$$

.

We can write our final expression so that it is ready for use in the derivation of Dyer-Roeder as:

$$\Phi_{00} = \frac{1}{2a^2} \left[\left(\frac{\dot{a}}{a} \right)^2 - \frac{\ddot{a}}{a} \right]. \qquad (29)$$

Now that we have Φ_{00} we are ready for the final derivation of the Dyer-Roeder equation using the N-P null-tetrad.

Geodesic Deviation and Angular Diameter Distance
The Dyer-Roeder equation is an equation for angular diameter distance. Angular diameter distance, as discussed in section 2.3, is the length of an object divided by the angle subtended by the object according to some observer in a flat FLRW cosmology. For our derivation of angular diameter distance we rely on the geodesic deviation equation. The geodesic deviation equation will supply the diameter of the object, or (*l*), from section 2.3. Geodesic deviation refers to the behavior of rays of light as they travel through some space and how that behavior deviates from a linear behavior. Two

light rays traveling in a flat space will diverge linearly or not at all (figure 5). In order for the light rays to diverge non-linearly they need to be accelerated. This acceleration, in a clumpy cosmology, is provided by the curvature of the space-time. We measure this acceleration by taking the second derivative of the displacement vector between the rays of a light bundle with respect to time. If this derivative is a constant the space is flat, if it is not a constant the space is curved(see figure 5).
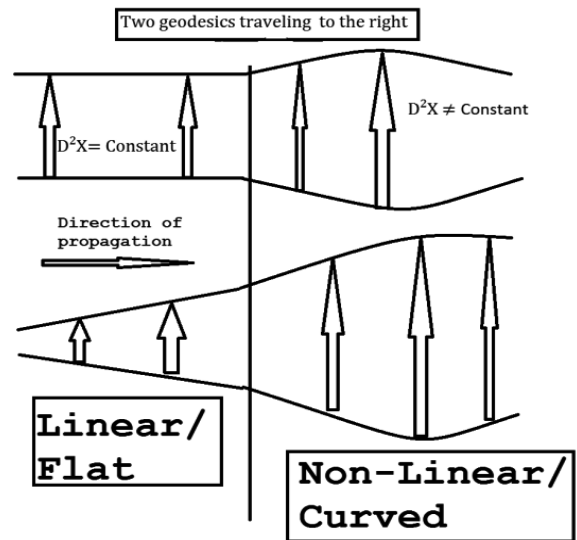
Figure 5: Shows two sets of two light rays(geodesics) traveling through a flat space on the left and a curved space on the right. The geodesic deviation vector X is represented by the arrows and changed linearly in the flat space and non-linearly in the curved space. The second order deferential operator D^2 measures the extent to which the geodesics are accelerating.

In the N-P formalism the second derivative is replaced by a second order differential operator (D^2). We apply this operator to a set of two complex vectors $\zeta \, \& \, \eta$ and their complex conjugates. Together with the complex vectors $m \& \overline{m}$ from our null tetrad, we can calculate the

real vector q for the displacement of light rays in a light bundle.

$$q = \zeta \overline{m}^a + \overline{\eta} m^a \qquad (30)$$

In the N-P formalism the geodesic deviation vectors are collected in the matrix X.

$$X = \begin{bmatrix} \zeta & \eta \\ \overline{\eta} & \overline{\zeta} \end{bmatrix} \qquad (31)$$

The differential operator (D) is the operator used in the N-P formalism [Kling Campbell(2008)]. By applying (D) two times to the deviation vectors we are in effect measuring the distortion of an image as viewed by an observer due to some acceleration caused by the curvature of the space-time. The differential operator (D) is given by a the change along the light ray, (l^a):

$$D = l^a \frac{\partial}{\partial x^a}. \qquad (32)$$

We will show that dividing the deviation vectors X by the angle subtended in an observer's sphere of light will yield the equation for angular diameter distance as described in section 2.3,

$$D_A = \frac{l}{\theta} \rightarrow \frac{X}{\theta} \qquad (33)$$

which is the Dyer-Roeder equation. We can then solve the geodesic deviation equation for the deviation vectors X. In the N-P formalism is

$$D^2X=QX \qquad (34)$$

where,(Q) is the matrix which codes for the effects of the space time on the deviation vectors,

$$Q = \begin{bmatrix} \Phi_{00} & \Psi_0 \\ \overline{\Psi}_0 & \Phi_{00} \end{bmatrix}. \qquad (35)$$

As discussed in section (1) the Weyl tensor vanishes and the Ricci component is given by equation (19).

Deriving the Dyer-Roeder Equation from the Geodesic Deviation Equation

Our goal is to start with the geodesic deviation equation and to derive the Dyer-Roeder equation. The geodesic deviation equation can be expressed in the N-P formalism as,

$$D^2X=QX. \qquad (36)$$

In this equation Q,X are given by equations (35) and (31). The matrix product QX in equation (34) is calculated as:

$$QX = \begin{bmatrix} \Phi_{00}\zeta + \Psi_0\overline{\eta} & \Phi_{00}\eta + \Psi_0\overline{\zeta} \\ \overline{\Psi}_0\zeta + \Phi_{00}\overline{\eta} & \overline{\Psi}_0\eta + \Phi_{00}\overline{\zeta} \end{bmatrix}. \qquad (37)$$

Since D^2X can be represented in matrix form as $D^2 X = \begin{bmatrix} D^2\zeta & D^2\eta \\ D^2\overline{\eta} & D^2\overline{\zeta} \end{bmatrix}$, we can write the following four equations:

$$D^2\zeta = \Phi_{00}\zeta + \Psi_0\overline{\eta} \qquad (38)$$

$$D^2\eta = \Phi_{00}\eta + \Psi_0 \qquad (39)$$

$$D^2\overline{\eta} = \overline{\Psi}_0\zeta + \Phi_{00}\overline{\eta} \qquad (40)$$

$$D^2\overline{\zeta} = \overline{\Psi}_0\eta + \Phi_{00}\overline{\zeta} \qquad (41)$$

In this case D is an operator which acts on the components of the matrix X as follows:[2]

$$D = l^a \frac{\partial}{\partial x^a} = l^0 \frac{\partial}{\partial t} + l^3 \frac{\partial}{\partial z}. \qquad (42)$$

Which means $D^2 = l^a \frac{\partial}{\partial x^a} l^b \frac{\partial}{\partial x^b}$. The Dyer-Roeder equation calculates distances in a flat-homogeneous cosmology, or a cosmology

described by the FLRW metric, where Φ_{00} is equation (19) and $\Psi_0 = 0$. Since the Dyer-Roeder equation is written in terms of red-shift distance (z_R) and matter density (Ω_m) we need a change of variable from time (t)in equation (42) to the red-shift distance and matter density. We don't need to worry about the χ derivative in equation (42) because neither l_a nor Φ_{00} depend on χ and the second terms in equations (38)-(41) vanish. To accomplish a change of variables we utilized the Hubble parameter (Ryden 2003).

$$H \equiv \frac{\dot{a}}{a}, \qquad (43)$$

The null vector l^a:

$$l^a = \frac{1}{a\sqrt{2}} \langle -1, 0, 0, \frac{-1}{a} \rangle, \qquad (44)$$

And the relationship between red-shift distance and the cosmological scale factor $a(t)$. This is generally $\frac{a(t_0)}{a(t)} = 1 + z_R$, where ($t_0$) is the time now, so by letting $a(t_0)=1$ we can write,

$$\frac{1}{a(t)} = 1 + z_R. \qquad (45)$$

By solving equation (45) for z_R and taking the derivative of both sides with respect to time we get,

$$\frac{\partial}{\partial t} = \frac{-\dot{a}}{a^2} \frac{\partial}{\partial z_R}. \qquad (46)$$

As discussed, since nothing in equation(17) depends on χ, and by substituting equations (43 - 46) into equation (42) we get:

$$D = l^0 \frac{\partial}{\partial t} = -l^0 \frac{\dot{a}}{a^2} \frac{\partial}{\partial z_R} = -\left(-\frac{1}{a\sqrt{2}}\right)\left(\frac{\dot{a}}{a^2}\frac{\partial}{\partial z_R}\right) = \left(\frac{1}{a^2\sqrt{2}}\right)\left(H\frac{\partial}{\partial z_R}\right),$$

or,

$$D = \frac{\sqrt{2}}{2}(1+z)^2 H \frac{\partial}{\partial z_R}. \qquad (47)$$

Operating with this differential operator two times can be expressed in terms of equation (43) and equation (45) by taking the appropriate derivatives and simplifying.

$$D^2 = \frac{1}{2}H(1+z_R)^2 \frac{\partial}{\partial z_R} H(1+z_R)^2 \frac{\partial}{\partial z_R} \qquad (48)$$

First we deal with the derivatives,

$$\frac{\partial}{\partial z_R} H(1+z_R)^2 \frac{\partial}{\partial z_R} = H(1+z_R)^2 \frac{\partial^2}{\partial^2 z_R} + \left(\frac{\partial}{\partial z_R} H(1+z_R)^2\right)\frac{\partial}{\partial z_R}$$

and,

$$\left(\frac{\partial}{\partial z_R} H(1+z_R)^2\right)\frac{\partial}{\partial z_R} = (1+z_R)^2 \frac{\partial H}{\partial z_R} \frac{\partial}{\partial z_R} + 2(1+z_R)H\frac{\partial}{\partial z_R}.$$

Then by combining the last two equations and simplifying,

$$H(1+z_R)^2\frac{\partial^2}{\partial^2 z_R} + (1+z_R)^2\frac{\partial H}{\partial z_R}\frac{\partial}{\partial z_R} + 2(1+z_R)H\frac{\partial}{\partial z_R} = H(1+z_R)^2\frac{\partial^2}{\partial^2 z_R} + \left((1+z_R)^2\frac{\partial H}{\partial z_R} + 2(1+z_R)H\right)\frac{\partial}{\partial z_R}$$

.Substituting this result into equation (48) gives,

$$D^2 = \left[\frac{1}{2}H(1+z_R)^2\right]\left[H(1+z_R)^2\frac{\partial^2}{\partial^2 z_R} + \left((1+z_R)^2\frac{\partial H}{\partial z_R} + 2(1+z_R)H\right)\frac{\partial}{\partial z_R}\right].$$

By distributing $H(1+z_R)^2$ we can write,

$$D^2 = \frac{1}{2}\left[H^2(1+z_R)^4\frac{\partial^2}{\partial^2 z_R} + \left((1+z_R)^4 H\frac{\partial H}{\partial z_R} + 2(1+z_R)^3 H^2\right)\frac{\partial}{\partial z_R}\right].$$

We now factor out a $\frac{1}{2}$ and we have D^2 in terms of redshift distance and the Hubble parameter in a form that will become useful later in our derivation.

$$D^2 = \frac{1}{4}\left[\left[(1+z_R)2H\frac{\partial H}{\partial z_R} + 4H^2\right](1+z_R)^3\frac{\partial}{\partial z_R} + 2H^2(1+z_R)^4\frac{\partial^2}{(\partial z_R)^2}\right].$$

$$(49)$$

Since in a flat FLRW cosmology $\Psi_0 = 0$, equation (38) becomes $D^2\zeta = \Phi_{00}\zeta$. Dividing both sides by the angle α (see section 2.3), where $D_A = \dfrac{\zeta}{\alpha}$ and D_A is the angular diameter distance, we get [Ryden, B. (2003)]:

$$D^2 D_A = \Phi_{00} D_A. \tag{50}$$

Then by substituting equations (49) and (29) into equation (50) our expression becomes:

$$\frac{1}{4}\left[\left((1+z_R)2H\frac{\partial H}{\partial z_R}+4H^2\right)(1+z_R)^3\frac{\partial D_A}{\partial z_R}+2H^2(1+z_R)^4\frac{\partial^2 D_A}{(\partial z_R)^2}\right]=-\frac{1}{2a^2}\left[\left(\frac{\dot{a}}{a}\right)^2-\frac{\ddot{a}}{a}\right]D_A, \tag{51}$$

From equation (43) we have:

$$\frac{\partial H}{\partial t} = \frac{\ddot{a}}{a} - \left(\frac{\dot{a}}{a}\right)^2. \tag{52}$$

Where we substitute equations (46) and (52) into equation (51) we get,

$$\frac{1}{4}\left(\left[(1+z_R)2H\frac{\partial H}{\partial z_R}+4H^2\right](1+z_R)^3\frac{\partial D_A}{\partial z_R}+2H^2(1+z_R)^4\frac{\partial^2 D_A}{(\partial z_R)^2}\right)=\frac{-1}{2a^3}\left[\frac{\dot{a}}{a}\frac{\partial H}{\partial z_R}\right]D_A. \tag{53}$$

By combining equations (43) (45) and (53), then setting the expression equal to zero and multiplying both sides by 4 we get:

$$\left[2H^2(1+z_R)^4\right]\frac{\partial^2 D_A}{(\partial z_R)^2}+\left[(1+z_R)^4 2H\frac{\partial H}{\partial z_R}+4(1+z_R)^3H^2\right]\frac{\partial D_A}{\partial z_R}+\left[(1+z_R)^3 2H\frac{\partial H}{\partial z_R}\right]D_A=0. \tag{54}$$

The only variable that does not depend on red-shift distance in equation (54) is the Hubble parameter and its derivatives which depend on t indirectly through $a(t)$. The Hubble parameter can be expressed in terms of redshift distance by the

Hubble constant H_0. For the most general case, not flat and uniform, can be expressed as:

$$H^2 = H_0^2\left[\frac{\Omega_m}{a^3}+\frac{1-\Omega_m-\Omega_\Lambda}{a^2}+\Omega_\Lambda\right]=H_0^2\left[\Omega_m(1+z_R)^3+(1-\Omega_m-\Omega_\Lambda)(1+z_R)^2+\Omega_\Lambda\right] \tag{55}$$

We are trying to find the Dyer-Roeder equation as it appears in Ehlers(1992). In this version the author assumes that $\Omega_\Lambda = 0$. In our metric we assume that the cosmology is flat, or that $1-\Omega_m-\Omega_\Lambda = 0$ [[Carroll,S. (2004)]. This reduces equation (55) to:

$$H^2 = H_0^2\Omega_m(1+z_R)^3. \tag{56}$$

Taking the derivative of both sides with respect to the red-shift distance we get,

$$\frac{\partial H^2}{\partial z_R} = 2H\frac{\partial H}{\partial z_R} = 3H_0^2\Omega_m(1+z_R)^2. \tag{57}$$

By substituting equation (56) and (57) into equation (54) we get,

$$\left[2(1+z_R)^4\left[\Omega_m H_0^2(1+z_R)^3\right]\right]\frac{\partial^2 D_A}{(\partial z_R)^2}$$
$$+\left[\left((1+z_R)^4(3H_0^2\Omega_m(1+z_R)^2)\right)+\left(4(1+z_R)^3(\Omega_m H_0^2(1+z_R)^3)\right)\right]\frac{\partial D_A}{\partial z_R}$$
$$+\left[3H_0^2\Omega_m(1+z_R)^3(1+z_R)^2\right]D_A=0 \tag{58}$$

Reorganizing we get,

$$\left[2H_0^2(1+z_R)^7\Omega_m\right]\frac{\partial^2 D_A}{(\partial z_R)^2}$$
$$+\left[\left(3H_0^2(1+z_R)^6\Omega_m\right)+\left(4H_0^2(1+z_R)^6\Omega_m\right)\right]\frac{\partial D_A}{\partial z_R}$$
$$+3H_0^2\Omega_m(1+z_R)^5 D_A=0 \tag{59}$$

Dividing both sides by $H_0^2(1+z_R)^5$ and combining the coefficients of the first derivative in the differential equation we get,

$$2(1+z_R)^2\Omega_m\frac{\partial^2 D_A}{(\partial z_R)^2}+7(1+z_R)\Omega_m\frac{\partial D_A}{\partial z_R}+3\Omega_m D_A=0.$$

(60)

I did not divide by Ω_m in the last simplification in order to make it clear that we have forced $\Omega_m=1$ because we assumed $0=1-\Omega_m-\Omega_\Lambda$ and Ehlers assumes $\Omega_\Lambda=0$. When we divide both sides of equation (60) by 2 and setting $\Omega_m=1$ we get:

$$(1+z_R)^2\frac{\partial^2 D_A}{(\partial z_R)^2}+\frac{7}{2}(1+z_R)\frac{\partial D_A}{\partial z_R}+\frac{3}{2}D_A=0.$$

(61)

This is our final expression for angular diameter distance in a flat FLRW cosmology. This is the same expression that is found in Ehlers', after setting $\Omega=1+\frac{kc^2}{(R_0 H_0)^2}=1$. For flat FLRW $k=0$. The Actual expression for Dyer-Roeder on pg. 137 of Ehlers' book is:

$$(z+1)(\Omega z+1)\frac{\partial^2 D}{dz^2}+(\frac{7}{2}\Omega z+\frac{\Omega}{2}+3)\frac{\partial D}{\partial z}+\frac{3}{2}\Omega D=0.$$

(62)

By setting $\Omega=1$ Ehler's expression reduces to:

$$(z+1)(z+1)\frac{\partial^2 D}{dz^2}+(\frac{7}{2}z+\frac{1}{2}+3)\frac{\partial D}{\partial z}+\frac{3}{2}D=0.$$

Finally, by combining like terms and factoring the second term, Ehler's equation matches our expression from equation (61), where $z_R=z$, or:

$$(z+1)^2\frac{\partial^2 D}{dz^2}+\frac{7}{2}(1+z)\frac{\partial D}{\partial z}+\frac{3}{2}D=0,$$

(63)

This means that by using the N-P formalism and starting from the geodesic deviation equation in a flat FLRW cosmology, we have reproduced the Dyer-Roeder equation.

Conclusion

We have shown that the N-P formalism can give us an equation for angular diameter distance that matches those obtained using traditional coordinate basis. We used the flat FLRW metric and the null tetrad to derive the Dyer-Roeder equation from the geodesic deviation equation. Our derivation is an expression for angular diameter distance in terms of red-shift distance. We were able to confirm that we have the right expression for angular diameter diatance by comparing it to the Dyer-Roeder equation in Ehlers(1992). Now that we have shown the N-P tetrad capable of producing the Dyer-Roeder equation for a flat FLRW metric, we think it is possible derive the Dyer-Roeder equation for angular diameter distance in a perturbed FLRW cosmology from the geodesic deviation equation. This derivation also serves as proof that the Dyer-Roeder equation is the geodesic deviation equation.

Next Steps

As discussed in the introduction, our final expression is only valid for objects to which we have a clear line of sight. This restriction is a result of starting with the the unperturbed flat FLRW metric. For objects to which we do not have a clear line-of-sight, we must account for the curvature

produced by the presence of clumps of matter along the line-of-sight. This can be done by perturbing the FLRW metric with gravitational potential and allowing for global curvature. By using the null tetrad we think, it is possible to find useful expressions for angular diameter distance in a perturbed FLRW cosmology. We believe that using the null-tetrad will simplify the mathematics and allow us to solve the the geodesic deviation equation for angular diameter distance. If so, the resulting equation could prove to be a useful tool for astronomers looking at objects through gravitational lenses.

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About the Author

Aly Aly is a double major in physics and mathematics graduating in spring 2015. His research project began in 2014 with funding provided by an Adrian Tinsley Program summer research grant and was mentored by Dr. Thomas Kling (Physics). He plans on attending graduate school in fall of 2015 and hopes to earn a Ph.D. in Physics.

Racial and Cultural Anxieties in Poe's *The Narrative of Arthur Gordon Pym*

Alyssa Amaral

American author Edgar Allan Poe's dark, cryptic, and often morbid works have captured the attention of literary critics and engaged the world in scholarly conversation and critical analysis. Among such works is Poe's *The Narrative of Arthur Gordon Pym*, a text that recounts Pym's horror-filled experience with mutinous and murderous uprisings on the *Grampus*, a devastating shipwreck that results in a ravenous act of cannibalism, and ultimately, the unfortunate landing on the southern island of Tsalal. It is on this island, which is symbolically black in entirety, where the Gothic and travel narrative plots begin to fuse with the deeper concepts of racial and cultural concerns of the 1800s. A novel that examines issues of race and racial divisions, *Pym* is riddled with racial and cultural polarities, highlighting the tensions between the two distinct regions of antebellum North and South United States. In fact, based on a world where North and South, white and black, and civilized and savage tragically collide, it is hard to escape the continual presence of racial conflict on the southern island of Tsalal. Moreover, through Pym's emphasis on documenting Tsalal's peculiar physical nature, along with the racial and cultural polarities between the white, northern men and the black, southern natives, Poe's *The Narrative of Arthur Gordon Pym* suggests that man has a natural desire for cultural and racial division. Furthermore, through the desire for racial division and the brutal conflicts that ensue between Pym's crew and the natives, Poe highlights the South's cultural anxieties about slave uprisings in the mid-19th-century.

Influenced by both Gothic fiction and travel narrative, *The Narrative of Arthur Gordon Pym* follows Pym, a resident of Nantucket, and his desire for adventure at sea. Snuck on board the Grampus by his close friend Augustus, Pym hides in the shadows below the boat's deck where he faces starvation, thirst, decay, and horror. Eventually resurfacing on deck, Pym takes part in helping Augustus and Dirk Peters, a "hybrid" native, overthrow the mutinous uprising that has occurred during Pym's prolonged confinement. After successfully regaining command of the ship, Pym, Augustus, Peters, and Parker, a merciful activist in the uprising, soon fall victim to a storm that leaves the *Grampus* in floating pieces. While floating for weeks on fragments of the vessel, hopeless and hungry, the men resort to cannibalism, a great trial for Pym. After Parker is viciously murdered and Augustus has died from severe wounds and exhaustion, Pym and Peters are soon discovered by Captain Guy and the *Jane Guy* of Liverpool. During the crew's extensive exploration of the uncharted South, they come across the peculiar island of Tsalal, a place dominated by black and void of white. Struck by the foreign characteristics of the island and the seemingly friendly, curious natives, the crew establishes trade and northern culture. As the novel progresses, however, the men grow wary of the subtle increase of the number of natives, an increase that leads to the gruesome and horror-filled attacks on the white northern men. Through attempts to bury the men alive, explode the *Jane Guy*, and eliminate any evidence of white culture, the "savages" are swept into a rage of barbaric fury. In a desperate attempt to flee Tsalal, Pym, Peters, and their native captive steal a canoe and begin their trek north, where blackness fades into the distance and whiteness enters on the horizon. After the strange, racially-influenced death of Nu-Nu, Pym and Peters witness an ambiguous figure at the conclusion of the novel, as they sail off to their suggested deaths.

Genres in *Pym*

Thomas Willis White's 1834 establishment of *The Southern Literary Messenger* provided Poe the much-needed economic opportunity to publish his work, as well as exposure to popular, influential, 19th-century literary genres. With the establishment of his magazine, White hoped "to stimulate the pride and genius of the south, and awaken from its long slumber the literary exertion of this portion of our country" (100). Soon after the magazine's release, however, White, self-educated and feeling "inadequate to making editorial decisions that involved literary judgments," felt overwhelmed and required help (100). In correspondence with Poe in early 1835, White invited Poe to write for the magazine. Seeing the opportunity to support himself and his wife, Virginia, Poe quickly accepted. In his biography on Poe, *Edgar A Poe: Mournful and Never-Ending Remembrance*, Kenneth Silverman explains:

> Nothing in Poe's literary expertise entitled him to speak so confidently about the business of magazine publishing. But his air of expertise was well founded on a canny understanding of what interested the growing republic. And much of his understanding, in turn, came from his eager effort to find an audience for his own work. (101)

Though not an experienced editor by any means, Poe understood the importance of appealing to his audience through popular genres, and recognized that by doing so, his works

might earn him an income. With this understanding, Poe quickly embraced his reading public's interest in the Gothic genre, evidenced as Gothic elements began to make dominant appearances in Poe's work. Drawing upon the uncanny, horror, decay, the supernatural, and other Gothic components in Blackwood's magazines, Poe's work emphasized the fear of:

> Enclosure and premature burial, animated portraits and tapestries, putrescence and physical decay; the depiction of garishly lit dwellings, particularly mansions and castles, as enclosing a nightmarish domain of the fantastic and irrational; the use of mirrors, interior decor, and external landscape to reflect psychological states. (Silverman 112)

In fact, many of these components exist in Poe's *Pym*, such as Pym's forced enclosure and premature burial, along with the foreign landscape of Tsalal that reflects cultural anxieties of the 1800s. However, Silverman importantly points out that Poe's understanding of Gothic fiction was not simply limited to the above mentioned ideas. Silverman elaborates that Poe not only imitated popular Gothic tales, but also "enriched [Gothic tales'] texture, managing to preserve the narrative drive of some central action while embroidering the whole with philosophical speculation and lore that deepen the mood of a dire awe, and with sense details that lend the improbable events a feeling of reality" (112-113). Silverman asserts that the Gothic events that occur in Poe's writings often touch upon issues of reality. As I will shortly discuss, Poe's Gothic elements portray "philosophical speculation" and "improbable events [that elicit] a feeling of reality," and draw upon 19th-century cultural anxieties of slave revolts (113). By using gothic horror to emphasize such fears, Poe not only captures the reading public's attention by creating a novel that embodies their interest in Gothic fiction, but also verifies and accurately captures a culture's fear. Much like the prominence of the Gothic in Poe's work, the travel narrative genre, too, played an important role in the writing of *Pym*. With society's increasing interest in the exploration and expansion of America, the reading public's interest also grew. In her critical exploration of race in American literature, Dana D. Nelson, author of *The World in Black and White*, explains, "Between 1800 and 1850 America witnessed a simultaneous surge in scientific professionalization and expansionist fervor which cumulatively resulted in the Anglo-American theory of Manifest Destiny" (92). She continues, "Pym's fictional adventure is situated squarely in this expansionist, Anglo-Saxon ideological context" (93). As Nelson suggests, the 19th century was a period of exploration and scientific explosion. The growing emphasis on Manifest

Destiny, the widely held belief that Americans were destined to expand throughout the continent, sparked an interest for the reading public to learn more about American expansion. Consumed by the thought of discovery, readers longed to hear the accounts of foreign and adventurous travels, a demand that contributed to the travel narrative's canonization as a 19th-century popular genre, as well as the travel narrative's significant influence in *Pym*.

A fictional story that documents not only Pym's secret confinement, experience as a hostage, and cannibalism-inducing shipwreck at sea, *Pym* also documents the Jane Guy's southward exploration of wildlife, vegetation, and weather on the multiple islands of Tristan d'Acunha, Kerguelen, Marion, and Tsalal. In the preface of *Arthur Gordon Pym*, Pym records his encounter with a group of "several gentlemen in Richmond, VA., who felt deep interest in all matters relating to the regions I had visited, and who were constantly urging it upon me, as a duty, to give my narrative to the public" (432). The exploration-promoting men who confront Pym desire the public announcement of his experience and discovery. Interestingly, Pym's society seems to parallel Poe's reading public, a society that places value on the documentation of exploration and expansion. Although Poe draws upon the Gothic and travel narrative, *Arthur Gordon Pym* can be interpreted as a text that reflects 19th-century America's views on race, an interpretation that will be explored throughout this essay. With this interpretation, it is important to note that *Pym* is a work of fiction, and therefore, does not necessarily represent Poe's personal views on race. However, this is not to say that critics and scholars have dismissed this idea. In his critical text "Antebellum Slavery and Modern Criticism," John Carlos Rowe argues that Poe was an avid proslavery Southerner and that such racial views are reflected in *Pym*. Contrarily, Terence Whalen's "Average Racism" explores the scholarly debate that *Pym* emphasizes the "insidious and terrifying" realities of slavery and race relations (925). While both scholars may provide compelling evidence to support their assertions, one cannot necessarily determine Poe's personal beliefs from his fiction.

Tsalal's Peculiar Nature

As a text greatly influenced by the travel narrative, *Pym* provides detailed and vivid descriptions of the unique and odd characteristics of Tsalal, particularly documenting the strange phenomena of the island's natural elements. Soon after landing on the island, Pym is thrust into a peculiar and foreign environment, different "essentially from any hitherto visited by civilized men" (530). Pym records the island's unique vegetation, explaining, "The trees resembled no growth of either the torrid, the temperate, or the northern frigid zones, and were altogether unlike those of the lower southern latitudes we had

already traversed" (531). The overwhelmingly foreign landscape of Tsalal is unlike anything Pym and the crew have previously encountered during their exploration. As Pym delves further into the wilderness, he comes across a stream, noting that the water "was not colourless…the whole mass of liquid was made up of a number of distinct veins, each of a distinct hue; that these veins did not commingle; and that their cohesion was perfect in regard to their own particles among themselves, and imperfect in regard to neighboring veins" (531). The Tsalalian water and its strange composition seem peculiar to the Northern men, to say the least. The water, composed of varying veins of colors, and furthermore, varying shades of color, depicts the organized separation of different entities within the stream, segregated from those of different colors. Dana D. Nelson's insightful exploration of racial polarities in *Pym* touches upon the idea of the vein's segregated state as she writes, "A Manichaean world where…colors dominate but do not mix, Tsalal in effect underwrites the color line of the antebellum South, and Pym's observations of the island highlight its segregated nature" (96). Nelson argues that importance must be placed upon the separation, or better yet, the aversion of colors in *Pym*. Furthermore, her assertion motions for a deeper analysis of the water, its veins, and its composition.

Captivated by the water's foreign characteristics, Pym continues to observe how the veins react to his attempts to mix them. Pym remarks, "Upon passing the blade of a knife athwart the veins, the water closed over it immediately…all traces of the knife were instantly obliterated. If, however, the blade passed down accurately between two veins, a perfect separation was effected, which the power of cohesion did not immediately rectify" (531). Pym's initial attempt to blend the veins by cutting the veins "athwart," or across, is unsuccessful (531). The veins remain in their segregated state. Yet when Pym tries to cut "between" the veins, that is, a calculated cut along their edges, he finds that his cut segregates the veins even further. Through both attempts, Pym is unable to mix the naturally segregated state of the veins.

The water and its veins' peculiar aversion and refusal to mix create an interesting and illuminating image that reflects the cultural and racial issues of 19th-century America. More specifically, the water and its veins represent individual and national bodies during this time, both figuratively and physically. By equating the water's intricate color system with veins, Poe prompts his readers to associate the water's veins with physical bodies. If the veins are representative of bodies, then the veins of differing colors and shades parallel the differing skin colors that exist in America. It can then be deduced that the segregated state of the veins represents the segregated state of 19th-century America. Furthermore, the veins' aversion to

mix is a representation of 19th-century America's hesitancy for races to mix, an idea that will be explored throughout this essay.

Tsalalian Aversions to White
In exploring the strange and symbolic landscape of Tsalal, Pym is once again thrust into an environment that is different from his own, forced to experience a culture dominated by the color black. Through his exploration, Pym finds that the Tsalalians' complexions are "jet black, with thick and long woolly hair. They were clothed in skins of an unknown black animal… their arms consisted principally of clubs, of a dark, and apparently very heavy wood….the bottoms of their canoes were full of black stones" (528). The animals, too, are "covered in black wool" (533). The Tsalalian's fondness for and interaction with the color black are indeed very strange: their clothes, tools, weapons, animals, and even complexions are black in entirety. However, with the landing of the *Jane Guy* upon Tsalal, the Tsalalians' black culture is intruded upon by white objects, the first instance occurring as Captain Guy waves a white handkerchief to signify peace. It is in this moment that the natives' initial aversion to the color white is portrayed. Pym explains, "Captain Guy now held up a white handkerchief on the blade of an oar, when the strangers made a full stop, and commenced a loud jabbering all at once, intermingled with occasional shouts…they continued this for at least a half an hour" (527). Through their shouting of "Anamoo-moo!" and "Lama-lama!" the Tsalalians exhibit their strange reaction, and perhaps rejection, to the color white. However, this is never made clear as their language is incomprehensible to the white northerners (527). And although Poe's audience is never directly enlightened on the reason behind this wild reaction to white, Poe takes great care to show that the natives do not like the idea of the interaction of white and black in their culture.

Through the interactions between the white, northern men and the black, southern islanders, Poe begins to illuminate the racial polarities between the two different cultures. Nelson examines this idea as she asserts, "Racialist polarities structure the island of Tsalal….The narrative suggests that the all-black Tsalalians instinctively avoid anything white. Their surprise at sighting the crew of the *Jane Guy* signals to Pym 'that they had never before seen any of the white race'" (96). The natives not only fear the color of the crew, like Nelson suggests, but also the items that the crew carry on the boat. As the natives curiously and systematically explore the vessel, they show a natural aversion to anything white. Pym explains, "We could not get them to approach several very harmless objects -such as the schooner's sails, an egg, an open book, or a pan of flour" (530). Nelson explains that the natives "recoil" when faced with white, which she asserts "indicates a 'natural' aversion between

races, shared by black and white alike" (96).

Much of this text is influenced by 19th-century American culture. As noted above, the natives "recoil" and reject anything white, anything different from what they are used to. This suggests that black has a natural hesitancy to mix with white (529). On the other side of the racial spectrum, Pym and the crew view the natives as "savages," and constantly carry around arms for protection. These instances and actions reflect each culture's reciprocal fear of the other. In regard to this idea, Nelson remarks, "Isn't it interesting that the Tsalalians seem to consider white to be as evil and dangerous as we consider black?" (96). An illuminating point; perhaps Nelson suggests that the white northern men believe themselves to be superior to the natives, believing that only black is to be feared, not white. Nonetheless, through both cultures' fearful reaction to the other, Poe highlights the animosity between the two drastically different cultures.

The conclusion of the novel brings with it Nu-Nu's death, which depicts nature's inability to fuse two cultures, and reiterates Poe's idea that man desires cultures remain segregated. Having miraculously survived and escaped the brutal and fatal attack by the natives, Pym and Peters leave the island with Nu-Nu, a black native whom the men have taken hostage. As the white men and their hostage set sail on the stolen canoe, they embark on their journey northwards, away from "savagery" and toward "civilization," away from the looming blackness of Tsalal and toward the bright whiteness of the North. Through Nu-Nu, we witness, yet again, the islanders' natural aversion to white. Pym explains, "We attached a sail made of our shirts… the sight of the linen seemed to affect him in a very singular manner. He could not be prevailed upon to touch it or go near it, shuddering when we attempted to force him, and shrieking out *Tekeli-li!*" (558). Here we see the black aversion to white, the incomprehensible shouting of fear and rejection. Poe then continues to describe the act of removing black from its natural habitat, the forcing of Nu-Nu away from the South and into the culture of the North.

As the trek northward continues, more whiteness is introduced to Nu-Nu, which ultimately results in his death. Pym records, "A fine white powder, resembling ashes -but certainly not such -fell over the canoe…Nu-Nu now threw himself on his face in the bottom of the boat, and no persuasions could induce him to arise" (559). (The white powder that Pym documents would appear to be snow, although that is never directly stated.) Nu-Nu, refusing to accept the snow and its whiteness, reacts not only by throwing himself into the bottom of the boat, but soon after, as if making a last act of defiance and reminder of his culture, separates his lips and displays "the teeth which

lay beneath it. These were black. We had never before seen the teeth of an inhabitant of Tsalal" (559). Nu-Nu, realizing that his separation from Tsalal is growing farther and farther, defiantly asserts his black culture by baring his all-black teeth. He soon after perishes.

To many critics, Nu-Nu's death symbolizes the result of what happens when two very different cultures forcefully mix. Toni Morrison, author of *Playing in the Dark, Whiteness and the Literary Imagination*, reflects on Nu-Nu's death as Pym, Peters, and Nu-Nu embark on their journey away from black and towards white. Morrison analyzes the initial transition from black culture to white as she writes, "The first white image seems related to the expiration and erasure of the serviceable and serving black figure, Nu-Nu" (32). Morrison asserts that it is whiteness that kills Nu-Nu, the fear of leaving his black community and being forced into a white world. Through Nu-Nu's rejection of mixing with a white world, which results in his death, Poe implies that nature does not want to intermingle with significantly different aspects of itself. Nelson adds to the abundance of scholarship surrounding this event as she argues, "These events offer a segregationist parable: in the state of nature, black doesn't *want* to mix with white. Nu-Nu provides direct affirmation of this, convulsing and expiring in the face of an increasingly white environment" (97). Nu-Nu does not want to mix with white culture. The light purple veins of the water do not want to mix with the dark purple shades. The natives do not want to interact with the northern mens' white objects. Through all of these cultural and racially charged interactions and rejections, Poe suggests that man desires for cultures remain segregated, that the North and South remain divided.

The Tsalalian Rebellion

The latter half of Pym's experience on Tsalal is filled with horror, as a result of the savage attacks on the white men. Although the planned attacks are brutal, gruesome, and fatal, the buildup to the attacks are subtle and gradual. Pym first comments on the slowly growing number of natives as he records, "In the whole of this adventure we saw nothing in the demeanour of the natives calculated to create suspicion, with the single exception of the systematic manner in which their party was strengthened during our route from the schooner to the village" (535). Pym initially seems untroubled by the growing group. But his concerns slowly intensify over the course of the narrative, building until Pym realizes that "a very short while sufficed to prove that this apparent kindness of disposition was only the result of a deeply-laid plan for our destruction, and that the islanders for whom we entertained such inordinate feelings of esteem were among the most barbarous, subtle, and bloodthirsty wretches that ever

contaminated the face of the globe" (538). In a description filled with disgust, Pym foreshadows the tragic conflict that would soon ensue between the unknowing northerners and the "barbarous," "bloodthirsty wretches" (538).

Pym's diction in the above passage is illuminating, as it depicts the northerners' negative and horror-filled views of the savages. Yet, Pym's reflection is hypocritical. He comments on the natives' fake kindness that hides a "deeply-laid plan," while simultaneously boasting the crews' "inordinate feelings of esteem" for the savages (538). But did not the northerners, too, have ulterior motives that prompted their warm greeting of the natives? On a journey to explore uncharted territory, the crew was most likely prepared to set up trade among colonies if they found them on their way. On Tsalal, the men do just that. After playing nice with the natives, Pym explains, "In return for these good things we presented the natives with blue beads, brass trinkets, nails, knives, and pieces of red cloth… We established a regular market on shore, just under the guns of the schooner" (536). But while Pym may suggest that the crews' interactions with the natives are friendly, does referring to the natives as "savage" portray the crews' "inordinate feelings of esteem"? (538). Likewise, does establishing the trade with the natives "under the guns of the schooner" create a friendly and trusting environment? (538). In this moment, Poe highlights the reoccurring hypocrisy of the northerners, their failure to see that they are just as hostile as the natives.

Some scholars may argue that this passage, and *Pym* as a whole, reflects Poe's critique of white racism and colonialism, an assertion that is supported throughout the novel. The above passage portrays the white crews' ethnocentricity, as they immediately refer to the natives as "savages," simply because the natives' culture is different from their own. Furthermore, upon landing on Tsalal, the men soon after establish trade and propose to "erect suitable houses," both of which are sure signs of colonialism (536). Nelson's *The World in Black and White* examines this very idea of colonialist and expansionist happenings in *Pym*, specifically as she explores the concept of "rightness of whiteness" and the perceived correlation between "native" and "evil" (92). But whereas most 19th-century travel narratives expose their readers to the advantages of colonialism, Poe's *Pym* portrays colonialism's horrifying repercussions. And because such brutal attacks on white men occur within *Pym*, the assertion that *Pym* is a critique of white racism and colonialism is clearly evidenced. Furthermore, scholars who assert that *Pym* is a critique of racism and colonialism would perhaps interpret the natives' attacks as a warning against colonialist motives and actions. Through Poe's casting of colonialism as having gruesome repercussions, he critiques expansionist actions, suggesting that colonialism will not be accepted by

all cultures, as seen through the natives' barbaric attempts to cast white presence out of their environment. Having drawn many readers in through the highly desired genre of the travel narrative, Poe exposes his readers to the horrors of rejected colonialism. But while the text illustrates the northerner's colonialism, it also vividly captures and emphasizes the revolting tragedies that come with it. Moreover, Poe's portrayal of conflict between the white men and the natives, I argue, has a more centralized focus on 19th-century cultural anxieties over slave uprisings, rather than providing a critique on white colonialism.

To be more specific, the 1830s was a time dominated by racial concerns regarding slavery and slave uprisings. Poe's *Pym* was written in the middle of the worrisome haze of southern slave revolts. John Carlos Rowe, author of "Antebellum Slavery and Modern Criticism," explores the fear of slave uprisings in Poe's *Pym*, looking through the lens of the Nat Turner revolt, a Virginian slave rebellion with the highest number of fatalities recorded in the American South. In his critical text Rowe argues, "Poe writes this long narrative in the historical context of decades of Southern white anxieties regarding the possibility of widespread slave revolts, recently made real in Turner's revolt" (912). With such tragic events occurring just seven years before *Pym's* 1838 publication, and furthermore, in one of Poe's home states, it is hard to ignore the parallels between the historically documented southern fear of revolts and the same racially charged revolts depicted in *Pym*.

While Rowe argues that *Pym* was influenced specifically by the Nat Turner revolt, Daniel Rasmussen's historical narrative, *American Uprising*, exemplifies the parallels between 19th-century slave revolts and the uprisings that occur in the latter half of *Pym*. Rasmussen's text vividly captures, recreates, and documents the New Orleans slave rebellion, occurring between January 6 and January 29, 1811. The uprising was spurred not only by the slaves' desire for independence, but also by their contempt for plantation owners and militia. The slaves' destruction and brutal clashing with New Orleans slave owners is what links these events with those that occur between the white northerners and black Tsalalians in *Pym*. Furthermore, Rasmussen's text is an illuminating exploration of a historic 19th-century slave revolt, a revolt that left southern slave owners with the looming and haunting fear of possible slave uprisings in their community. This ingrained fear of a slave revolt was present in both Poe and his southern readers' minds during the publication of *Pym*, evidenced by the countless parallels between the events depicted in *American Uprising* and the Tsalalian rebellion in *Pym*. It is important to note, however, that although the 1811 revolt was alive and present in Poe's mind during the writing of *Pym*, Poe does not

directly use the 1811 New Orleans slave revolt as a rubric for his novel. Within the context of this exploration, Rasmussen's *American Uprising* is instead a tool that exemplifies how the Tsalalian rebellion in *Pym* closely mirrors 19th-century slave revolts. This then illustrates how Poe draws upon cultural anxieties surrounding slave revolts, and incorporates those same concerns into his text.

Such gruesome and fatal attacks previously mentioned begin with the natives' attempt to crush the northern men with rocks. Before being cast into a world of darkness, Pym describes the sudden awareness of "a concussion resembling nothing I had ever before experienced" (540). He describes being "tombed alive," the "blackness of darkness which envelops the victim, the terrific oppression of lungs, the stifling fumes…[that] unite with the ghastly considerations that we are beyond the remotest confines of hope" (540). Because of the natives' revolt, Pym experiences the horror of confinement, the dread of blackness that surrounds him, and the heavy, overbearing oppression of the rocks. Through this, the black natives force Pym into a seemingly inescapable captivity. Pym is filled with horror, shock, and dread. Within this moment, Poe draws upon the cultural fears of a slave rebellion. Pym, a white male, comes to represent the white slave holders of the South. The natives, completely black, come to symbolize revolting southern slaves. It is Pym, a representation of the white South in this instance, who falls victim to the savage and fear-instilling attacks of the natives, or, the black southern slaves.

Rasmussen's *American Uprising*, much like Poe's *Pym*, captures the destruction of property and the murder of white men. Rasmussen recounts from the 1811 revolt that "there was a large number of rebel slaves moving down the river, pillaging the farms and killings whites," actions that resemble the Tsalalians' raid of the *Jane Guy* and their murder of the crew on board (108). Having escaped the avalanche of the rocks, Pym and Peters stumble upon a hideous and tragically gruesome scene, where Pym documents the *Jane Guy* "surrounded by an immense multitude of desperadoes evidently bent upon capturing her at all hazards," an echo of the 1811 slaves' attempts to take over white plantations and communities (544). Pym continues:

> Our men were borne down at once, overwhelmed, trodden under foot, and absolutely torn to pieces in an instant. Seeing this, the savages on the rafts got the better of their fears, and came up in shoals to the plunder. In five minutes the Jane was a pitiable scene indeed of havoc and tumultuous outrage. The decks were split open and ripped up; the cordage, sails… demolished as if by magic. (545)

The savages, enraged and swept into a fit of madness, destroy everything in their sight, as if in spite of the northern explorers. Pym's crew and friends are viciously murdered while he is forced to witness the chaos from a distance. The images of the white crews' murder closely resemble the murders of white slave holders in the New Orleans slave revolt, in which "slaves lunged…slicing passing bodies with three long cuts… hack[ing] Gilbert Andry into pieces" (Rasmussen 99-100).

The demise of the *Jane Guy*, specifically the moments leading up to and after her explosion, are important to emphasize, as both instances work to portray the natives' actions as influenced by their contempt for white. The six remaining crew members, in a last attempt to fend off the natives, fire the boat's cannon, killing some, but not enough. Soon after, the relentless and barbaric natives forcefully overtake the boat and its crew. Even after the barbaric deaths of several of the shipmates, the natives' savagery continues. In a desperate and brutal attempt to completely eliminate the presence of white in their culture, the natives set the *Jane Guy* on fire. Upon the deadly explosion, Pym documents, "The whole atmosphere was magically crowded, in a single instant, with a wild chaos of wood, and metal, and human limbs" (546). This instance, in which the black savages work to destroy any remnants of white crew members and objects, represents 19th-century southern fears of slave uprisings that were believed to result in crippling destruction, gruesome deaths, and the inability to stop it. This image, of uncontrollable and explosive destruction, resonates with Rasmussen's portrayal of the New Orleans community members' inability to stop the 1811 slave revolt. Rasmussen depicts such physical limitations as he writes, "With the white residents of the area clustered behind the city gates and the black slaves marching from the fields, it seem all [anyone] could do was pray" (121). This historic description of helplessness during the New Orleans slave revolt aligns with Pym's feelings of vulnerability as he watches the natives tear apart the *Jane Guy*.

After the explosion that results in the death of 1,000 Tsalalians and the mangling of another 1,000, Pym witnesses some peculiar ceremony on the shores of the island. As he watches the crowd of Tsalalians surround something, a gap in the circle allows him to notice "something white lying on the ground… at length we saw that it was the carcass of the strange animal with the scarlet teeth and claws which the schooner had picked up at sea on the eighteenth of January" (547). The animal Pym sees is indeed the cat-like animal referenced in Pym's January 18th journal entry. Described as having "straight silky hair, perfectly white," the animal that the Tsalalians surround symbolizes the last remains of white culture (527). Through the natives' explosion of the *Jane Guy* and their celebratory

dance around the animal while screaming "Tekeli-li! Tekeli-li," the Tsalalians not only assert their hatred for white by casting the last remaining remnants of white out of their society, but also assert their dominance as a black culture.

Looking through the lens of the natives' brutal revolts, Rowe proposes that the conflict between white and black on Tsalal is not the only instance in the novel where the black race seems to be the aggressor. He draws upon the earlier events in *Pym*, which depict the murderous mutiny onboard the Grampus where the white race fall victim to the savagery of the black race. Specifically, he examines the Black Cook, the leader in charge of the murderous uprisings and the slaughter of dozens of white men. Through this casting of barbaric actions by the black race, Poe reiterates his culture's fears of a black rebellion, fears that were heightened during the 1831 Nat Turner Rebellion. Rowe comments specifically on this idea as he continues, "Like Nat Turner, the Black Cook strikes his victims on the head, testifying to the symbolic danger to reason posed by the emergence of irrational savagery so many Southern whites imagined would accompany slave rebellion or even legal emancipation" (914). Through analysis of Poe's description of savage attacks by members of the black race, both on the *Grampus* and on Tsalal, Rowe echoes Poe's suggestion that the fear of slave rebellions in the 1800s, and the black race itself, was a fear ingrained into American culture. In fact, many 19th-century canonical works follow and mimic Poe's racially-charged footsteps, such as Herman Melville's 1846 novel, *Typee: A Peep at Polynesian Life. Typee* explores Polynesian native life and themes regarding cultural absorption, but also depicts the native practice of cannibalism and acts of "noble" savagery. Both Poe and Melville's 19th-century works are drawn to the primitive, uncivilized, and savage cultures of native islanders, which suggest an ingrained cultural interest and fear of native race and culture.

A Haunting Figure
The ambiguous concluding scene of *Pym*, in which an indistinguishable figure emerges, is a racial topic belonging to its own category. Poe's description of the figure has sparked countless scholarly debates and conversations regarding its meaning. G. R. Thompson, editor of *The Selected Writings of Edgar Allan Poe*, footnotes the multiple interpretations of the ending's significance. He explains, "The ambiguous conclusion of the narrative and the mysterious figure have generated numerous critical interpretations from the literal to the symbolic and allegorical: e.g., fog, and ice formation, the figurehead of the returning ship Penguin, Christ, God, an angel, Death, the Ancient Day" (560). However, I would like to propose something different–that as Pym and Peters "rushed into the embraces of the cataract, where a chasm threw itself

open to receive us," the men see, either figuratively or literally, the outline and figure of a penguin (561).

As a text largely influenced by the travel narrative, Poe spares no expense in documenting the surrounding environment that Pym passes through during his southward adventure toward Tsalal. While sailing south on the *Jane Guy*, Pym documents the animal life found on Kerguelen's Island. He records descriptions of vast numbers of sea elephants, and more importantly, the abundance of penguins. "Penguins are very plenty," Pym writes:

> and of these there are four different kinds….They carry their heads high, with their wings drooping like two arms, and, as their tails project from their body in a line with the legs, the resemblance to a human figure is very striking, and would be apt to deceive the spectator at a casual glance or in the gloom of the evening. (513)

Something like that "gloom of the evening" is present at the time in which Pym sees the figure, as he describes the "cataract, where a chasm threw itself open" (560) and the "fine white powder, resembling ashes," presumably snow (513). With the combination of fog and mist from the cataract, along with the falling snow, the poor visibility Pym experiences masks the defining features of the penguin, dissembling and blurring its outline into the appearance of something else entirely, such as the multitude of interpretations scholars have previously suggested.

Poe's emphasis on the cultural fear of southern slave uprisings and racial mixing serve as evidence that the "shrouded human figure" is in fact that of a penguin (560). Considering Poe is writing in the antebellum period, a time filled with tension surrounding the idea of race, the significance of a penguin at the end of the novel, the natural mix of both black and white, may indeed make sense. As Pym witnesses the horrors of what happens when black and white interact, both culturally and racially, he faces brutal and gruesome realities. This ghostly figure of the penguin as Pym leaves the island reminds Pym of the horrors he encountered between the natives and himself, of what happens when black and white forcefully collide. Yet if Pym's experience in the latter half of the novel serve to represent the southern fear of slave revolts, then the penguin's looming black and white presence not only serves as a reminder to Pym of his horrific experience while on Tsalal, but also represents the South's haunting, lingering fear of the mixing of black and white in their culture.

Scholars who argue that the figure at the conclusion of *Pym* represents God or Christ may rebut this argument, asserting

that the figure is entirely white, and thus, does not portray a penguin. They may draw upon Pym's description of the figure, in which he states that "the hue of the skin of the figure was of perfect whiteness of the snow" (560). This description suggests that the figure is white in entirety, but consider the visibility and darkness that surround the canoe. Pym explains, "the sullen darkness now hovered above us…the darkness had materially increased, relieved only by the glare of the water thrown back from the white curtain" (560). If the figure is indeed a penguin, the black portions of its figure would mix with its dark surroundings, resulting in its display of more realistic proportions, as the loss of black area creates a more slender, human figure.

On the contrary, if we take this description literally, that the penguin is entirely white, then does this shatter the argument that the penguin is a symbolic representation of Pym's gruesome and fearful experience on Tsalal? Does this then ruin the assertion that the penguin portrays America's racial and cultural concerns for antebellum America? Perhaps not. In her critical text, Morrison observes, "The image of the white curtain and the 'shrouded human figure' with skin 'the perfect whiteness of the snow' both occur after the narrative has encountered blackness" (32). This observation is interesting, as it illustrates not only Pym's physical movement away from blackness and toward whiteness, but also suggests his increasing desire for only white. Moreover, having been exposed to the black culture of the Tsalalians, Pym has a desperate desire to return to white society. Pym fears the natives, he fears their culture, and most importantly, he fears black. Having witnessed the tragedies and aggressions that result when cultures mix, Pym now understands what will happen if black and white collide. Knowing this, Pym strips the penguin of its natural blackness not only because he fears it, but because he desires for black and white to remain segregated. Through Pym's rejection of black, Poe captures white slave holders' desire for race to remain segregated during the early and mid- 19th-century.

Although I have argued that the penguin serves as a looming and haunting reminder to both Pym and antebellum South that black and white should never mix, it is important to acknowledge other critics' suggestions that the figure holds divine or angelic importance. As scholars assert that the figure is that of "God, Jesus, [or] an angel," some imply that the figure serves as a positive or hopeful representation of Pym's encounters on Tsalal (560). With the understanding that the figure is that of a penguin, then perhaps the penguin's looming presence works to represent a desire for racial harmony. A natural mix of black and white, the penguin proves to the doubtful Pym that black and white can coexist in nature, and therefore, in his community. If we view the penguin's mixture of black and white as

positive, then we can also assume that perhaps, after witnessing and experiencing the devastation of clashing black and white cultures, that the penguin symbolizes Pym's longing for a community that exists in racial harmony. By viewing the penguin in a positive light, then it becomes clear as to why countless scholars have imagined the ambiguous figure as angelic or divine. However, this argument becomes more complex when we consider the setting and situation in which the penguin appears. The penguin, "shrouded," looming, and blurred, makes its appearance after the catastrophic destruction of the *Jane Guy* and brutal murder of the white crew (560). Appearing as Pym flees Tsalal in desperate search for white civilization, the penguin's presence serves a darker and bleaker significance (560). While scholars may claim that the penguin holds angelic importance, I argue that the penguin's looming black and white presence serves not only as a haunting reminder to Pym of his experience on Tsalal, but also portrays the South's lingering fear of the cultural mixing of black and white.

Edgar Allan Poe's *The Narrative of Arthur Gordon Pym* is a truly remarkable representation of cultural divides between antebellum North and South in the 1800s. Through his combination of gothic fiction and travel narrative, Poe masterfully captures the attention of a wide ranging audience. An exciting and thrilling, yet dark and morbid text, *Pym's* plot not only captures the audiences' attention, but holds it. With this undivided attention, Poe is able to submerge his readers into a world of racial and cultural polarities, a world where neither black nor white dominate, but instead, avoid each other at all costs. Pym's documentation of the peculiar characteristics of the water serves a deeper meaning within the text, portraying nature's fear of the mixing of colors. Through this illuminating metaphor, Poe suggests that 19th-century America, too, has anxiety over the mixing of two drastically different cultures and races, a fear for the cultural mixing of white slave owners and their black slaves. In the latter half of *Pym*, the brutal happenings that ensue between Pym and the natives vividly capture the cultural anxieties of slave revolts in the South, which were believed to end with only catastrophic destruction and gruesome, racial upheaval. And ultimately, an interesting and highly debated figure at the conclusion, the penguin comes to serve as a looming and haunting reminder to not only Pym, but to the antebellum South, that black and white should never mix. Moreover, although a gritty and tension-filled work, Poe's *The Narrative of Arthur Gordon Pym* is a thought-provoking work that affirms 19th-century American culture and anxieties, as well as tells a written escapade that encapsulates a young man's journey of adventure and heartbreak, gain and loss, thrill and terror, and black and white.

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About the Author

Alyssa Amaral is a senior majoring in English and minoring in history. Her honors project was completed in the fall of 2014 under the mentorship of Dr. Ann Brunjes (English) and made possible with funding provided by Bridgewater State University's Office of Undergraduate Research. Alyssa plans to attend graduate school in the fall of 2016, pursuing a Master of Arts in Teaching (MAT) and English.

"The Chambers of the Sea" and a "Knock Upon the Door": Questioning Meaning in T.S. Eliot's "The Love Song of J. Alfred Prufrock" and "The Waste Land"

Mara Araujo

Man has often struggled to understand the pain and suffering that plagues human existence. Out of the rubble of war and the breakdown of the individual, only fragments remain, pieces scattered about yet bound by the journey within. This is the world of Prufrock; this is the world of the wasteland. Considered by many to be T.S. Eliot's finest works, both "The Love Song of J. Alfred Prufrock" and "The Waste Land" present broken thoughts, images, and allusions, fused together to reveal the disintegration of the modern world. In "Prufrock," allusions to great art, literature, and heroic Christian figures serve as ironic comparisons to a prudent, cautious man who is unwilling to commit. Though he searches for answers in his struggle, Prufrock's stifling idleness and inhibition ultimately place him in his own private hell, the Inferno from which there is no escape. Similarly, in "The Wasteland," the recurring allusions, among them Shakespeare's The Tempest and Dante's Purgatory, highlight the speaker's quest for meaning in a seemingly meaningless and desolate landscape. Nevertheless, the various speakers in "The Wasteland," united in the blind prophet Tiresias, find themselves in Purgatory, searching for illumination and salvation. Thus, "The Wasteland" differs from "The Love Song of J. Alfred Prufrock" because, although the speakers in both poems are searching, Prufrock's journey ends in definite pessimism while the speaker in "The Waste Land" is left still searching.

One need look no further than the title of "The Love Song of J. Alfred Prufrock" to see how fatally doomed Prufrock is. For instance, there is usually an expectation that a love song should be tender and beautiful, yet his name inspires no such sentiments. What is audibly clear, however, is the rhythmic dissonance between the "love song" and the unromantic Prufrock. In fact this first ironic juxtaposition announces all future ironies, which set Prufrock apart as a failure. The title is then followed by six lines of Italian poetry taken directly from Dante's Inferno. The epigraph relates the words of Guido da Montefeltro, a man forever trapped in the Inferno, who confides in Dante because he does not believe Dante can escape hell and reveal his secrets to the world. Critics regard this as a telltale sign of Prufrock's inevitable demise, for Dante will return to write his poem, but Prufrock cannot escape his private hell (Ellis). Prufrock is trapped by "an overwhelming question" which he constantly toys with yet never fully addresses (Eliot 10). He notices in a room the women who "come and go / Talking of Michelangelo" (Eliot 13-14). He wants to open the door and speak to one of the women, but he cannot do it. Instead, he contemplates the "yellow fog" and "yellow smoke" that "curled once about the house, and fell asleep" (Eliot 20-22). Thus, his "own lack of resolve is like the languid fog, the cultivated boredom of ordinary, passive citizens" ("The Love Song"). Furthermore, his "lack of resolve" also stands in high contrast with Michelangelo, one of the art world's most influential figures. Of course, this is but one of the many instances where Prufrock is left comparatively weak.

As he continues his rationalizations, Prufrock believes that "indeed there will be time" (Eliot 23). The constant excuse for procrastination becomes a recurring thought, inspired by Andrew Marvell's 1681 poem "To His Coy Mistress." Unlike Prufrock, Marvell's speaker argues that there is not enough time, and he and his lover must hurry to consummate their relationship. In other words, Marvell's speaker is a man of action; however, Prufrock is not. Prufrock proves to be not only indecisive, but also highly insecure. He is acutely aware of his "bald spot" and grows increasingly concerned that others will also notice his "thin" arms and legs. All he can do is daydream about the women he longs to talk to, yet even in his daydream his ability to communicate is hindered by insecurity and fear that the women will belittle him. He is, as J. Hillis Miller observes, "like a man running in a dream. However far [he] goes, he remains imprisoned in his own subjective space, and all his experience is imaginary." As he becomes increasingly self-conscious, Prufrock longs for simplicity. Prufrock believes he "should have been a pair of ragged claws / Scuttling across the floors of silent seas" (Eliot 73-74), rather than the bold man that would live out his desires. He admires even shellfish, the lowest form of life, if only for their movement "because they neither think nor speak; they simply act, something he is unable to do" (Blythe).

Although Prufrock's continues to cite great historical and literary figures, their greatness only serves to highlight his inadequacy. Even as he envisions his head "(grown slightly bald) brought in upon a platter," he is "no prophet" like the martyred

John the Baptist (Eliot 82-84). The comparison to greatness is no comparison at all, undone by the fixation on his bald spot. As he becomes more and more vulnerable, Prufrock continues to suggest that he is not worthy of the role of main character and confesses that he is also "not Prince Hamlet." He negates his role as Hamlet, preferring instead the position of an attendant lord, "one that will do / To swell a progress, start a scene or two, / Advise the prince; no doubt, an easy tool…At times, indeed, almost ridiculous-- / Almost, at times, the Fool" (Eliot 111-119). Once again, the positive image is thwarted by the negative undertones. The Fool whom Prufrock so easily identifies with is Yorick, the dead fool in Hamlet. The theme of death that foreshadows the remaining lines of the poem becomes more pronounced.

Prufrock ends his "decisions and revisions" (Eliot 48) with a disconcerting final statement about the futility of the material world. He concludes with death as "human voices wake us, and we drown" (Eliot 126-130). The water, which serves as a possible source of revival and restoration in "The Waste Land," has the opposite effect in "Prufrock." The waves are nothing more than a cold reminder of his insecurity; even the imaginary mermaids will not sing to him. In Prufrock's world, life is a daydream and there is no clear delineation between the state of life and death. Rather, as Jonathan Childs writes, "Like souls in the Inferno, Prufrock exists in a kind of living death [and] the more life he has left to live, the more he is left to wonder and to question" his dreamlike state. He wastes time and never asks his question. Although his mind has been feverishly at work recalling great heroic figures of the past, they are only useful in exposing the chaos in his mind. They all represent something great to aspire to, yet Prufrock sees that he does not measure up. For Prufrock, life was over the day it began.

The death theme continues in "The Waste Land," but what sets it apart from "Prufrock" is that the positive images, although often linked with decay, offer hope or perhaps a way out of the wasteland. As "Prufrock" began with an Italian epigraph, so "The Waste Land" begins in a similar fashion. A Greek and Latin epigraph discloses the story of Sibyl, from Petronius' Satyricon. Sibyl wants to die because, although she was granted eternal life, she failed to ask for eternal youth and is confined to a bottle to live out her days as a wasted shell. The quote depicts not only the struggle of the denizens of the wasteland, represented by the imprisoned Sibyl, but also the struggle that one might have understanding the fragmentary form of poem. The use of multiple languages also signals the poem's universality, applicable to the struggle of all humans, independent of geography.

The first section of the poem, entitled "The Burial of the Dead," highlights a key problem for those stuck in the wasteland; the residents are resistant to a spiritual rebirth. Resistance is characterized not only by the various voices, but also by the setting. In the wasteland, "April is the cruelest month, breeding / Lilacs out of the dead land, mixing / Memory and desire, stirring / Dull roots with spring rain" (Eliot 1-4). In parody of Chaucer's "General Prologue" in The Canterbury Tales, neither spring nor rain is celebrated as a source of life. The winter, however, is said to have "kept us warm, covering / Earth in forgetful snow, feeding / A little life with dried tubers" (5-7). To be sure, "April is anthromorphically cruel. By trying to awaken irresponsive roots, it is cruel. Since rebirth implies some effort on [the Waste Landers part] and any spiritual effort is hateful to them, they prefer winter or spiritual death" (Vijaya). The jetsetter Marie explains her fright when, as a child, her cousin took her out on a sled (16-18). She, as with many of the characters that appear in "The Waste Land," is afraid to relinquish control. Marie prefers instead, "pleasure and physical comforts" rather than "the shower of rain [which] surprises her and she seeks shelter from it as she is unaware of its purifying and fertilizing significance" (Vijaya).

In the midst of the uninspiring images of the Waste Landers' obstinacy, the recurring signs of life remain persistent as a constant reminder of the possibility of revival. For instance, even as the modern world relies on the death predictions of Madam Sosostris, the "famous clairvoyant…known to be the wisest woman in Europe," the contrasting image of the drowned Phoenician Sailor with "pearls that were his eyes" serves as a reminder of the possibility of rebirth (Eliot 43-47). While Madam Sosostris provides a warning of death by water, the quote from Ariel's song in Shakespeare's The Tempest, alludes to the idea that death does not have to be the end:

> Full fathom five, thy father lies.
> Of his bones are coral made;
> Those are pearls that were his eyes;
> Nothing of him that doth fade
> But doth suffer a sea-change
> Into something rich and strange. (1.2.400-405)

In contrast to Prufrock's drowning, this drowning demonstrates the transformation that can occur to change circumstances in the wasteland. In closing the first section of the poem, the same image reoccurs in the form of a question posed by the speaker: "That corpse you planted last year in your garden, has it begun to sprout? Will it bloom this year?" (Eliot 70-71). Even though the question begins with the grotesque image of the corpse, the connection to the garden inspires the death and rebirth theme. The protagonist realizes that death carries the potential to sprout into a new life form.

In Section II, "A Game of Chess," a similar image insinuates into the chaos of a couple's sterile relationship. A wealthy upper-class woman, ironically compared to passionate figures such as Cleopatra and Dido, struggles to communicate with her husband. Even so, in the midst of her "strange synthetic perfumes/Above [her] antique mantel was displayed… the change of Philomel, by the barbarous king / So rudely forced; yet there the nightingale / filled all the desert with inviolable voice" (Eliot 87-101). The display of Philomel represents another life reborn from the death of the old. She has been purified through suffering, and even though the modern world only understands her song as a perverse "Jug Jug" (Eliot 103), her melody echoes still. Philomel's song also mirrors the wealthy woman's plea as she demands from her husband, "Are you alive, or not? Is there nothing in your head?" (Eliot 126) While her husband briefly contemplates Ariel's song, the woman continues to ask questions that remain unanswered. Their situation is left unresolved, yet they are "waiting upon a knock upon the door" (Eliot line 138). The woman desires to "break the narrow cage of routine to which she is tied, [and she] is waiting for something to happen" (Vijaya). In an active and desperate questioning of her current state, the woman is representative of humanity's hunger for meaning. Thus, her questioning distinguishes her from Prufrock, as he does not keep his search active but is instead drowned by the failure to find meaning. There are no answers for the woman as she is still in Purgatory, still seeking. That her search does not end highlights Eliot's changing vision, from the complete pessimism in Prufrock's world to the possibility of spiritual renewal in the dry wasteland.

Part III, or "The Fire Sermon," calls for purification by means of fire. It is here that Tiresias finally asserts his presence as the all-seeing observer and participant in "The Waste Land." He observes the typist preparing for an expected guest, and criticizes the mechanical sexual exchanges found in the modern age, declaring, "I Tiresias, old man with wrinkle dugs / Perceived the scene, and foretold the rest" (Eliot 228-229). After the sex act, which he compares to an assault, the woman, "puts a record on her gramophone," calling to Tiresias' mind the music coming from a church:

> This music crept by me upon the waters […]
> I can some times hear
> Beside a public bar in Lower Thames Street,
> The pleasant whining of a mandolin
> And a clatter and a chatter from within
> Where fishermen lounge at noon: where the walls
> Of Magnus Martyr hold
> Inexplicable splendor of Ionian white and gold.
> (Eliot 257-265)

Often considered one of the most encouraging images in the entire poem, this particular contemplation relates to a recurring image found in the Holy Grail and the Fisher King myths.

Eliot's interest in myths is pronounced as he "seems to imply that 'The Waste Land' is a modern grail legend, and that the overarching narrative of the poem is one of the journey to the empty chapel" (Bolton). The church is thus the quester's final goal, where the Grail will be found and used to restore the King's dry kingdom. Of course, the journey is not yet over and the speaker continues with the theme of the purifying fire, "Burning burning burning burning / O Lord Thou pluckest me out / O Lord Thou pluckest" (Eliot 308-310). His desperate cry carries both "a warning from Eastern religions against the sins of the flesh" and a "confession from the Western church father Augustine of his own foolish lusts," but the lines also illustrate the possibility of extracting meaning from the ashes (Taylor).

The Eastern influence originates in the section's title, a reference to the Buddha's Fire Sermon. In his sermon the Buddha suggests that "a rejection of earthly desire is the only way to be released from samsara, the cycle of birth and death that is the suffering characteristic of humanity" (Johnson). Likewise, Augustine, in his Confessions, recognizes the difficulty of leading a Christian life and the subsequent need to purge one's self of sexual sins and selfish desires. It is no coincidence that these allusions immediately follow two of the most sexually charged scenes of the poem. Consequently, in both the Western and Eastern reference, fire signals the need to cleanse one's lust. While readers may interpret the sexuality in this particular section as further evidence of the disintegration of the Waste Landers, the amalgamation of the two theologies culminate in the possibility of finding a way out of the wasteland.

Many critics find the events in the fifth and final section, "What the Thunder Said," also indicate the inescapable misery in the wasteland. Yet there are also fragmentary hints that the land may once again be restored to its former grandeur. Although lines 328 through 330 focus on "the living who are now dying / With a little patience," lines 360 through 366 reference a reassuring image of the risen Christ. The speaker asks,

> Who is the third who walks always beside you?
> When I count, there are only you and I together
> But when I look ahead up the white road
> There is always another one walking beside you…

Although Jesus was not recognized by two of his followers on the road to Emmaus, the important and positive aspect of this scene is that the speaker notices that Jesus is not only present, but that he is always present. The inquisitive nature of

the observation once again references the search for meaning among the ruins of the wasteland. The symbolic church associated with the Holy Grail now returns as "the empty chapel" (387-388) which, "on the surface suggests failure in the quest, but in Arthurian legend the moment of greatest despair is the necessary moment that precedes the discovery of the Grail." In keeping with the Christ imagery, the Easter story similarly describes "the despair of finding an empty tomb…followed immediately by the joy of discovered resurrection" (Taylor).

Here, the poem moves into a final "heap of broken images" (Eliot 22) as the voice of the thunder provides the three principles of renewal from the Indian Upanishads. Returning to the universal aspect of the poem, Eliot employs three Sanskrit words, which not only address the fundamental problems of the wasteland, but also allude to possible solutions. Datta, the first statement, translates into the giving of one's self. Though the following lines ascribe pride and survival as the primary motivation of humans, they also construct the sacrificial nature of love as a miracle, ultimately the one ideal that should matter in the world. The second statement, Dayadhvam, calls for compassion in a world filled with lonesome people locked inside themselves. Finally, Damyata stresses the importance of self-control. Each of the three statements "suggests a getting beyond the obsessions of self…as a first step toward personal and societal renewal" (Taylor).

In the final lines of the poem, the image of Phlebas, the Phoenician-Fisher King, returns. He awaits something beyond drowning while fishing for peace that "passeth understanding." He sits "upon the shore with the arid plain behind [him]" and questions, "Shall I at least set my lands in order?" (Eliot 423-425) While he has not yet found all of the answers, he wonders still if he should prepare his land for rain, reiterating the recognition that rain is not only necessary but also imminent. The remaining fragments repeat the Upanishads, followed by the last line "Shantith shantith shantith" (Eliot 434). In his notes, Eliot defines this line as "The Peace which passeth understanding," or more specifically as "God give me peace." The repetition of this phrase echoes Augustine's cry, and his realization in "The Fire Sermon" that "there is a higher power who can and does rescue him from his desperate circumstances" (Taylor).

Though there is much anguish and perversion in "The Waste Land," the end does not equal to the despair found in the opening lines. On the contrary, it "makes a promise and prophecy… [and] suggests that regeneration is possible as it always has been possible through suffering and penance. Man has sinned and he must atone to God for his sins through sufferings" (Vijaya). However intangible the definition of hope and peace, it is something the human soul still yearns for. Unlike "The Love Song of J. Alfred Prufrock," where religious references serve only as a comparative tool in order to expose Prufrock's shortcomings, in "The Waste Land," religious images signal the potential of a spiritual rebirth. The difference reflects a time in which Eliot "evinced a wary fascination not only with various denominations of Christianity, but with Buddhism, as well." Considering these earlier studies of different faiths and Eliot's eventual conversion to Christianity, one is left with a more optimistic reading of "The Waste Land." The poem "offers a bleak vision of modern life, but religion and literature remain the means by which one may transcend this bleakness" (Bolton).

By the end of "The Waste Land" and the "Love Song of J. Alfred Prufrock," it is clear that a journey has taken place. The journey is a chaotic excursion that has instigated many questions along the way. For Prufrock, the inner conflict regarding his place in a changing world leads to a dead end. The futility of life is the only meaning ascertained from his journey. In "The Waste Land" too, the threat of hollowness is ever present. The difference, however, is that even in chaos, in doubt, and in the questions raised by one's labored existence, there are always signs that the speakers are on the verge of finding a way out. The speakers, who serve as a symbol for all who wrestle with meaning and purpose, cry out for peace.

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About the Author

Mara Araujo is a graduating senior majoring in English and minoring in Communications. Her paper was completed in the fall semester of 2014 as part of the Modern British Poetry course taught by Dr. Tom Curley (English). Upon graduating, Mara plans to pursue a career in publishing.

Code-Switching in Portuguese Print Media of Brazilian Immigrant Communities in Massachusetts

Stephanie Castellarin

Code-switching (CS) is the alternation between two or more languages in the context of a single enunciation or written production (Poplack, 1980, Gardner-Chloros, 2009). Generally, CS occurs more commonly in spoken conversation than in written form, but it does manifest in both modes of communication (Gardner-Chloros, 2009). This study is prompted by the following research question: Does CS exist in Brazilian Portuguese print media in Southeastern Massachusetts? And if so, what does the use of non-standard Portuguese suggest about the (in)stability of Portuguese in the region? Since the early 20th century, linguists have recognized the phenomenon of CS in bilinguals. Initially, it was thought of as a random phenomenon until the early 1970s, when scientists began to recognize and investigate the conscious use of CS in a Norwegian village (Gardner-Chloros, 2009). Since then, experts in the field of linguistics have tackled the subject of CS from a plethora of perspectives in order to better understand the role it plays in language acquisition, attrition, and the formation of a social identity. The present study seeks to determine whether CS is occurring in the Brazilian community of Massachusetts, as evidenced by a review of the local print media. Print media was selected for exploration of evidence of CS because there is a large array of newspaper publications and magazines which are widely disseminated throughout the Southeastern Region of Massachusetts. Additional supportive evidence came from posted notices, ads, and local announcements, which are also widely available in community businesses

Literature Review

Poplack (1980) defines the three main types of CS in her study of the speaking patterns of twenty Puerto Ricans in a bilingual community in New York City. The subjects exhibited varying degrees of fluency in the two languages. More importantly, the results showed that CS was done even by non-fluent bilinguals, which adheres to what Poplack refers to as equivalence constraint. This constraint dictates that CS can only occur when L1 and L2 features are in accordance with syntax rules in both languages. She categorizes CS into three main types: tag-switching (or emblematic switching), morphological switching and intra-sentential switching. By providing this theoretical framework, she puts forth the idea that CS is an indication of the speaker's bilingual abilities. For the present study, Poplack's main categories of CS were used to classify the data gathered from Brazilian Portuguese print media sources.

Also important in the present study is the research completed by Pucci (2003). Pucci focuses mainly on the occurrence of CS in heritage learners and the resulting biliteracy encouraged by expanding the availability of print media in L1 and L2. It is important to note the high availability of print media in Portuguese in the South Shore communities that were analyzed in this research. Gardner-Chloros (2009) explores the implications of CS and what it may suggest about the development of the social identity of a community. A clear connection between the social identity of the expatriate Brazilian community and CS becomes clear through analysis of the data gathered for this research, as will be discussed later. Gardner-Chloros (2009) also explores the idea that the existence of CS has implications for attrition and language shift.

In fact, language shift and attrition are pertinent concepts in the study of immigrant communities. Bolonyai (2009) examines published works that suggest that CS may be linked to L1 attrition and imperfect acquisition. Attrition can be defined as a temporary or permanent decline in language skills, knowledge, or use. It is usually a result of intensive language contact. Imperfect acquisition refers to an erosion of L1 in children as a result of a lack of exposure to the target language, both in quality and quantity. Erosion is most often seen in third generation heritage learners of Brazilian Portuguese, that is, children of first or second generation immigrants (Ferreira 2005). Thus, the research investigating the relationship between CS and contact-induced language shift certainly links them close together. However, researchers are careful to highlight that they are not mutually exclusive, and point out that the process happens slowly.

Boyd (1993) argues that the structures of the languages in contact, as well as socio-historical aspects of that contact, play an integral role in deciding whether or not CS and borrowing between languages is an aspect of expansion or a signal of attrition. Her study focuses on two groups of immigrants to Göteborg, Sweden. One group is composed of Finnish immigrants and the other is made up of American immigrants. The Finnish community has a long standing history of immigration to Sweden. The Swedish words are integrated into

the Finnish more readily. This lexical transfer can eventually result in loanwords from the L2 language. On the other hand, the American immigrant communities in Göteborg are significantly smaller, dispersed randomly across various parts of the city. The Americans studied showed a lower rate of borrowed words or lexical transfer from Swedish. Thus, the author concludes that the unification and establishment of a particular immigrant community's expatriate identity directly affects their CS production and lexical borrowing. Similarly, the occurrence of CS found in the Brazilian print media would suggest that the expatriate community in Southeastern Massachusetts has created a well-established identity.

Hill (1993) explores language death and how attrition is an early indication of such death. Attrition in this article is defined as a process which manifests in an environment that profoundly subordinates the minority population, especially on a political and economic level. The process of attrition begins with grammar simplification and later a loss of grammar rules, until structure and productivity is lost. The author uses three different case studies to demonstrate: one involving indigenous people in Queensland, Australia, another in Mexico's Malinche region, and finally a study of the Wasco language spoken on a Chinookan Reservation in Oregon. All three groups are facing possible language death because of the social, political, and economic factors that are unfavorable to language symbiosis. Therefore, these groups can be marginalized for using their language. Eventually, they internalize the views and opinions from the greater majority, thus leading to a devaluation of the language within the group of minority language speakers. These speakers find it necessary to curb the usage of their language in order to integrate into the larger community. It is important to contrast with the present study because the current climate in the Southeastern region of Massachusetts is one which embraces linguistic diversity. There is an array of print media in Portuguese. There are a number of businesses that are owned or operated by the Brazilian community. However, if the social, political, or economic factors that support the current symbiosis of languages were to change, then CS may be an indicator of language erosion. In the worst case scenario, it would mean the loss of Portuguese spoken in the region, or language shift.

Although the study conducted by Major (1993) explores the acquisition of Portuguese and loss of English by five American English speakers who immigrated to Brazil, it has important implications for this study because of the idea of language loss and the concomitant creation of a new social identity. The study focuses on the loss of L1 native accent as a result of L2 acquisition. The results showed that L2 (in this case, Portuguese) clearly influenced L1 (English) and that the greater

the proficiency in L2 the more likely it is to influence L1. The results support the idea that a speaker will exhibit convergence as a means of social acceptance, efficient communication, and the creation of a positive social identity. At the same time, they will demonstrate divergence in order to emphasize their differences. In Mayor (1993), speakers who exhibited the most L1 loss were those that closely identified with Brazilian culture. It would be interesting to explore if increased L1 loss will manifest as the Brazilian community continues to assimilate into the culture in the United States. This adaptability also supports the forging of a unique identity within the new, larger culture

In sum, previous research shown here demonstrates that CS may happen alongside language shift and the possible creation of a new social identity. As stated before, a community might transition from the use of one language to another as a primary means of socialization and communication (Giacalone Ramat, 1995). The transition can only happen under circumstances in which the minority language is devalued by the society and its native speakers. In order for devaluation to occur, there must be a specific set of social, political, and economic circumstances that would propagate a negative perspective of the use of the language. Then the society must reinforce the perspective with negative consequences for its use. Evidence of CS would be one piece of the puzzle in determining if language attrition (and eventual language loss) might occur in Brazilian communities in Southeastern Massachusetts.

Methodology

The methodology consisted of gathering evidence of CS and non-standard Portuguese samples in various locations in Southeastern Massachusetts. Samples from newspapers and magazines published by immigrants in Portuguese-speaking communities were collected and analyzed for evidence of CS. In addition, samples of advertisements and notices, where CS or non-standard language occurred, were collected or photographed.

Data was collected in the towns of Stoughton, Quincy and Brockton. All of the locations chosen have well-established Brazilian communities, which have been documented by The United States Census Bureau and can be referenced in the map featured below in Figure 1. The Census does not differentiate between Brazilian Portuguese, Azorean and Cape Verdean Creole. Despite this compilation of languages and dialects, it is clear that the South Shore has a significant population of Portuguese speakers.

The well-established communities would suggest, based on research by Boyd (2009), a higher occurrence of CS or borrowing present in print media. Samples were collected from Brazilian Portuguese language newspapers such as Brazilian Times,
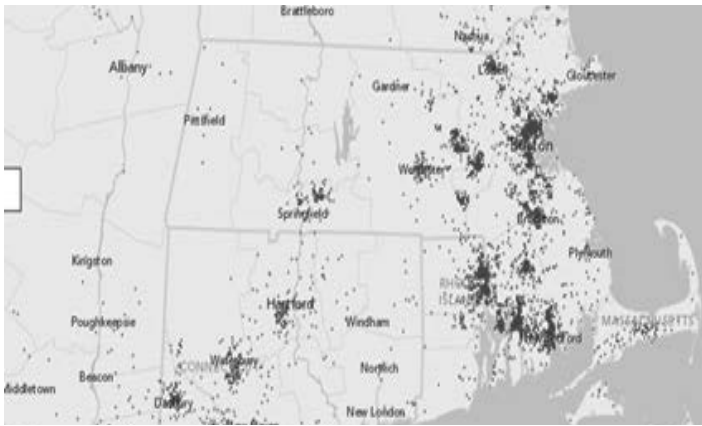
Figure 1. Map of Massachusetts and Portuguese-speaking populations.

Jornal dos Sports, and A Semana. Also, Brazilian magazines like Bate Papo and Tempo de Vitória were selected. In addition, several examples of written advertisement, which were hung on walls and in windows of Brazilian stores, churches, social clubs and bakeries, were either collected (if there were samples available) or a digital picture was taken (See Appendix 2). The advertisements were analyzed for examples of CS, orthographic errors or examples of non-standard Portuguese. Then, examples were carefully compared with the data gathered from previous studies in the areas of code switching, attrition and language shift.

Results and Discussion

The following are the results of data collection in the aforementioned towns of Southeastern Massachusetts. Categories of CS and other non-standard language are presented, according to the types put forth by Poplack (1980). CS samples were divided into two subcategories, those that were orthographically correct, as in example (1) and (2) and those that were not, as in example (3).

(1) Mais de $3.000 em prêmios, books <livros>, fotográficos, joias. ("More than 3,000 dollars in prizes, books, photographs, jewelry")

(2) tratamento estético e make up <maquiagem> & hair design <estilo de cabelo>. ("esthetic treatment, make-up & hair design")

(3) Procuro trabalho de *house kepper <empregada>.("I am looking for housekeeping work")

Orthographic and grammatical errors include misspellings as in (4), absence of diacritic marks in written Portuguese, and non-standard capitalization.

(4) *Concertamos <consertamos> seu celular quebrado. ("We fix your broken cell phone")

(5) *conheca <conheça> a kiddie academy faça uma visita, transporte escolar, câmeras de *seguranca <segurança> (Meet the Kiddie Academy, come for a visit, school transport, security cameras)

In example (5) the cedilla is omitted in "conheca" and "seguranca" but correctly includes it in the same line in the word "faça" (Imperative form of "to make," used in the colloquial expression "come for a visit"). It can be inferred from this discontinuity that the exemption of the cedilla is not due to the fact that the average computer keyboard in the United States does not have a key allocated for the diacritic mark. It could suggest that the Portuguese used in the United States is being amended to more closely resemble English since the English language does not use any diacritic marks unless the word is a foreign word that has been adopted into the vernacular. Samples belonging to a category of false cognates, such as in example (6) were gathered.

(6) *Aplicar <candidatar-se> pessoalmente. "apply in person"

Also, hybrid words that blended English and Portuguese, and any other anomaly that couldn't be classified, was put in that category. Table 1 summarizes the occurrence of each type of category found in the data.

Table 1: Summary of Data and Categories

Category of Instances	Number of Instances
CS (Correct Spelling)	64
CS (Incorrect Spelling)	8
Subtotal:	72
Orthographic Errors	27
False Cognates/ Anomalies	14
Total:	113

As can be noted in Table 1, there were 113 total number of data items collected, among them, examples of orthographic or grammatical errors, CS samples, false cognates and language anomalies. They were collected from six print sources. In general, print sources followed the standard orthography of Brazilian Portuguese. However, there were 35 instances in the data of incorrect spelling either in Portuguese or English. As also be noted in Table 1, the most common category of data collected was examples of CS. More specifically, the most common was the emblematic form, also known as tag switching, as defined by Poplack (1980). Its prevalent usage suggests an increasing degree of bilingual competence

among the Brazilian community. These examples of CS may also indicate a certain level of attrition in the written and spoken Brazilian Portuguese in the Southeastern Massachusetts. Based on the research of the Brazilian print media, it is difficult to ascertain whether or not this high frequency of emblematic CS is indicative of attrition or is contributing to an erosion of the native language simply because of the relatively small size of the samples collected. However, it can be noted that within the vernacular CS examples are leading to words that are morphological hybrids such as *parquear ("to park") in place of estacionar or *estou bisado ("I am busy") instead of estou ocupado. The listed examples are almost exclusively spoken and rarely written although examples of these morphologically mixed words will occasionally appear on social media site such as Facebook. However, anomalies or false cognates such as *aplicar ("to apply for a job" instead of candidatar-se) can be seen as the enrichment of language and expression through the addition of English words at a community level. It should be noted that there is a verb "aplicar" in Portuguese which means has many meanings, including "to invest." The most frequently reoccurring examples of false cognates were similar to (7) from the Jornal Dos Sports. See Appendix 1 for additional examples from Brazilian Times, among other print media.

(7) Serviços em *corte <tribunal> ("Court services").

This terminology was used in several different newspaper advertisements for lawyers and legal advocates. The problematic aspect is the use of the word corte as an equivalent to "court" in English. The actual definition in Portuguese is a royal court, such as a sovereign and his or her councilors. The word in Portuguese that actually denotes what is being expressed by this advertisement as corte is tribunal or "court."

The divergence from the monolingual is rapidly becoming the norm in local Brazilian communities; as a result the inclusion of both English and Portuguese is ubiquitously utilized in all of the magazines and newspapers that were assessed. This suggests not only a superior level of bilingualism within the Brazilian communities of this region, but also the presence of bi-literacy. Tokuhama-Espinosa (2003) suggests that the borrowing of words from English may be perceived to augment the "prestige" of the language, at least on an individual scale, which could be another explanation as to why tag switching is so pervasive in the Brazilian Portuguese print media.

The research done by Hammarberg (1993) explores the acquisitional process of L2 with particular emphasis on the learner's creative role in the process and the natural linguistic restraints that govern it. The linguistic restraints are analyzed by using recent theories of second language acquisition such

as markedness, simplification, and transfer. The standpoint taken by Hammarberg is that "strategic creativity and natural constraint" (p. 440) must be unified to achieve an integrated view because each plays an essential role in the L2 acquisition process. The results of German learners of Swedish showed that learners would opt for structurally uncomplicated solutions or they would transfer the rules from L1, also known as target-simplifying or transfer solutions. There was an especially unequal acquisition between cognates versus non-cognates suggesting that cognates were easier for the learner to lexically integrate. This may explain the usage of false cognates from Portuguese to English, through the acquisition process. Thus, the adjustment in the semantic usage of "corte" shows a lexical acquisition of the English non-cognate amongst the Brazilian community.

Conclusions and Further Research

The data collected suggest that there is no language contact without the presence of CS. This has been shown in the research by Poplack (1980), Bolonyai (2009), Gardner-Chloros (2009), and Boyd (1993) and also found in this study. Yet, the mere existence of CS within a community cannot be proven to categorically indicate language shift. There is certainly a connection between language attrition and CS. The connection, evident in the evolution of morphological hybrid words and amendments to the definition of words that are false cognates, occurs in Brazilian communities in the United States but is not occurring in Portuguese speaking countries. A complete language shift to English is unlikely for the local Portuguese speaking community in the near future simply because negative socio-economic and political ramifications for speaking Portuguese do not currently exist. Most likely a language shift will occur in this community only if there is a complete cessation of immigration of Brazilians to this region of the United States. Even then, the language shift would not be evident for generations. The presence of CS in their community's media is a prominent indicator of their emerging identity as Brazilians that immigrated to America and signifies a pervasive proficiency in both languages among the bilinguals within this community.

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About the Author

Stephanie Castellarin is a graduating senior majoring in Spanish and minoring in Portuguese. Her research on language shift in Brazilian Portuguese print media was completed during the fall semester of 2014 under the mentorship of Dr. Fernanda Ferreira (Foreign Languages). Stephanie plans to pursue a career in interpreting.

Exploring The Human Hepatocirrhosis Virus

Dawilmer Castillo

The Human Hepatocirrhosis Virus (HHV) infection of human hepatocyte cells leads to massive cell death that ultimately causes liver failure, a life threatening condition that demands urgent medical care. In the United States alone, HHV is responsible for approximately 2,800 deaths each year and causes irreversible tissue damage that affects over 8,200 people that will require lifelong treatment. Most often, liver failure occurs gradually over many years following HHV infection. The symptoms of the disease are swollen abdomen, mental disorientation, and even coma. To prevent infection from the HHV virus one should practice proper hygiene and safe sex and avoid consuming contaminated food and water. Understanding the functions, structure, mechanical processes and characteristics of HHV is crucial for early detection, treatment, and the development of a potential vaccine for the virus.

Pathology

HHV enters the human body through the mucosa of the mouth, nose, genital area, or open wounds in the skin; however, most infections originate from consumption of contaminated food or water. After the virus enters the body, it travels through the bloodstream until it reaches the hepatocytes in the liver (Figure 1a). Once it encounters the hepatocytes, HHV infects cells by binding to a specific receptor unique to hepatocytes and starts making copies of itself. The newly assembled viral particles exit the host cell and propagate into neighboring hepatocytes, causing massive cell death. This activates the immune system, which fight the spread of the virus and causes inflammation of the liver (Figure 1b). Since HHV propagates very fast it mutates frequently thus preventing the body from building long-lasting immunity to the virus. The viral infection and the constant release of chemicals by the immune system results in cirrhosis of the liver. Histologically, the HHV damage resembles liver damage by Hepatitis viruses, as shown in Figure 1. The liver does not have sufficient time to heal itself thus forming cirrhotic tissue. A cirrhotic liver cannot effectively synthesize proteins, filter the blood or regulate blood sugar levels. If left untreated, the loss of liver functions may cause death and other serious complications such as cancer. 8

Virion Characteristics

The Human Hepatocirrhosis Virus is an enveloped virus with icosahedral shape (Figure 2a) with an approximate size of 40 to 60nm. The virus also has the tegument, comprised of proteins that line the space between the envelope and the nucleocapsid (Figure 2b). These proteins mainly contribute to viral RNA replication, the elimination of cellular competition and the evasion of the immune response. Dawicasmer12 (DCM12) and Rocasmer14 (RC14) are glycoproteins present on the surface of the envelope and play an important role for viral attachment and entry to the host cell (Figure 2c). HHV has a negative sense single stranded RNA genome, which is linear and nonsegmented. The genome is relatively small (95kB), thus the virus has evolved several mechanisms to code as many functional proteins as possible as discussed below.

Virus Life Cycle and Interaction with Host Cell

After HHV enters the human body, the virus glycoprotein ligands (DCM12 and RC14) will bind to complementarily receptors on the surface of hepatocyte cells named DCM12-C and RC14-C. Next, the host cell engulfs the virion via enclosure into the cellular membrane forming a vesicle and intaking the HHV virus into the cytoplasm of the cell in a process called receptor-mediated endocytosis. Once inside of the cell, HHV will activate its M2 channels that will change the pH of the intracellular environment, disassociating the virion envelope, capsid and cellular vesicle. Release of the HHV RNA genome into the cytoplasm will start viral protein synthesis and replication using cellular machinery (Figure 3). The replicated HHV genome is packaged inside a newly synthesized capsid. The virus maturation and release will then follow with new HHV virions exiting the host cell via budding. The release of new HHV progeny allows for further infection of healthy cells, repeating the process (Figure 4). 5, 6

HHV Replication and Translation

HHV needs a RNA-dependent RNA-polymerase to replicate its negative sense ssRNA genome, an enzyme not found in animal cells. The virus codes for its own RNA-dependent RNA-polymerase and packages a functional enzyme in each virion. To start replication, the viral polymerase complex reads the (-)ssRNA genome 3' to 5' direction and it synthesizes the complementary (+)ssRNA strand 5' to 3' direction. The same polymerase complex will then read the (+)ssRNA and synthesize a new complementary (-)ssRNA strand (Figure 5a) which is then ready to be packaged in a capsid. 6

The virion RNA is negative sense (complementary to mRNA) and must therefore be copied into the complementary (+) ssRNA before viral proteins can be synthesized. (+)ssRNA is the same sense as cellular mRNA so it functions as a regular mRNA molecule. The newly synthesized viral (+)ssRNA

Effects of Viral Infection in the Liver
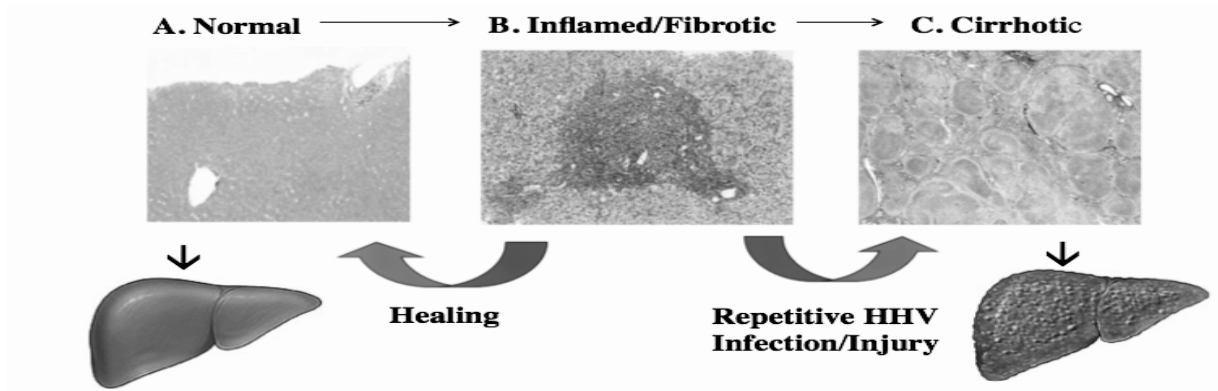
Figure 1. Histological appearance of hepatocytes isolated from an individual infected with HHV at different stages of progression during viral infection. A) Micrograph depicts normal/healthy liver tissue before viral infection; (B) inflamed/fibrotic tissue as occurs upon infection; and (C) cirrhotic hepatocytes after repetitive exposure to HHV and the activation immune system.

Virion Characteristics
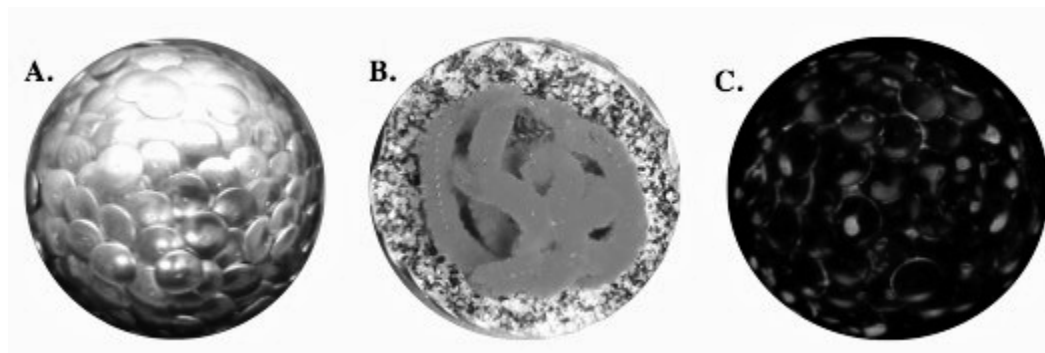
Figure 2. Model of the Human Hepatocirrhosis virus.
A virion constructed by using a 4-inch Styrofoam white ball and manually pinning gold and silver thumbstacks in a circular pattern. (A) The envelope of the virus is depicted by different thumbstack colors to represent the different proteins found in the envelope of the virion; (B) is a cross section image of the HHV virus made by cutting a Styrofoam white ball in half and painting the inside with black marker to represent the viral tegument. A red nylon chenille stem was then glued in the middle of the styrofoam ball which represents the -ssRNA genome of HHV that is encapsulated by the capsid (not depicted); (C) is a HHV model stained with green fluorescent dye (glow stick liquid) to represent the glycoproteins present on the surface of the virus used for identification of hepatocyte cells.

can be translated by cellular ribosomes resulting in protein synthesis (Figure 5b). It is critical for HHV to code for RNA-dependent RNA-polymerase in its genome and also package it in the virion capsid so that the polymerase can synthesize (+)ssRNAs upon infecting the cell so that translation and replication can occur. 6

Evolutionary Gadgets
HHV has a relatively small genome thus it can only code for few proteins. To overcome this, HHV has evolved several traits that allow it to compensate for its small genome and successfully compete with cellular molecules. HHV is polycistronic, meaning that a single viral mRNA molecule encodes for several different polypeptide chains. When the viral mRNA gets translated into proteins, multiple proteins are bound together. The viral mRNA is translated into large molecules in which multiple proteins are connected together into a polyprotein. Enzymes called proteases cleave the huge polyprotein resulting into separation of the individual pieces. HHV also encodes for viral de-capping enzymes that degrade
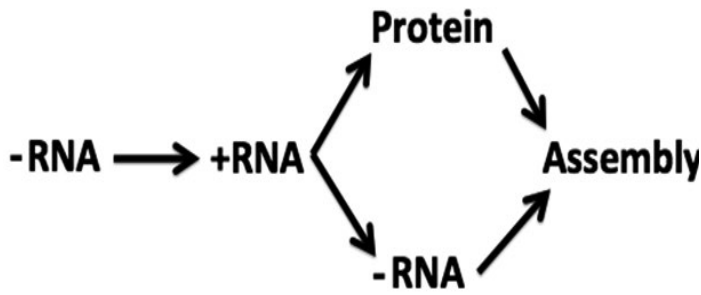
Figure 3. Schematic of the mechanism for HHV viral replication and protein synthesis. The HHV virus has a (-) ssRNA DNA that is synthesized into its complementary (+) ssRNA strand. The (+) ssRNA strand can then be translated (protein synthesis) by cellular machinery and replicated (formation of a newly synthesized viral genome). This results in the assembly of a new virus which will exit the host cell and infect new cells.

Figure 4. Schematic of HHV lytic life cycle and virus/host interaction at the cellular level. a) Virus binding (adsorption) and internalization (penetration, entry), b) cytoplasmic release and uncoating, c) IRES-mediated translation and polyprotein processing that directs the virus to the host endoplasmic reticulum, d) RNA replication (biosynthesis), e) packaging and assembly, f) virion maturation and release.4

the CAP structure of cellular mRNAs preventing them from being translated. This allows HHV mRNAs to be translated faster than cellular mRNAs. The virus can also use the CAP from the degraded cellular mRNAs and add it to its own mRNA molecules. 6 In addition, the viral mRNA has internal ribosomal entry site (IRES). This is a unique structure in the mRNA molecule of the virus allowing it to bypass the need of a CAP at the 5' end of the mRNA molecule in order for translation to occur. Thus, cellular machinery would translate

the sequence because IRES will mimic the CAP structure. Viral polyA polymerase adds a poly-A tail to all viral mRNAs. These evolutionary gadgets allow HHV to replicate and synthesize proteins efficiently by utilizing cellular machineries. 6

Immune Response and Genomic Changes
Due to a high mutation rate during HHV replication, the immune system is relatively inefficient. The lack of proofreading activity during viral replication results in genetic

HHV Replication and Translation
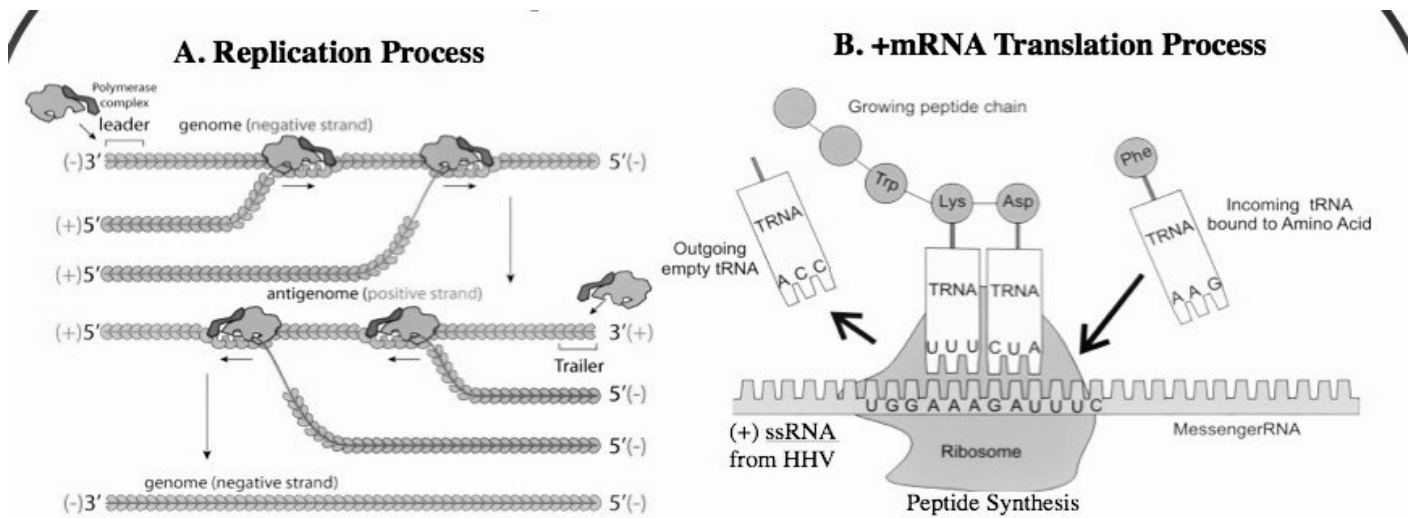
Figure 5. Schematic of HHV replication and translation. HHV has its own transcription and replication factors that allows proper synthesis of (-)ssRNA copies and proteins. (A) The (-)ssRNA from HHV gets synthesized to (+)ssRNA by a polymerase complex. Once it is a (+)ssRNA strand, the polymerase complex can replicate a new (-)ssRNA strand.9 (B) The complementary (+)ssRNA is translated and different proteins are synthesized using cellular machinery.1 The diagram in panel A originally appeared in Viralzone/Expasy database9.

drift, which is the change in the frequency of a gene variant in a population. The majority of these mutations continuously change the structure of the HHV virus, resulting in an activation of a new immunological response for the same virus. Thus, the antibodies that initially recognize and attack HHV no longer activate the immune system, therefore the immune system has to generate new antibodies, which takes time. By then, the virus has already gained new mutations, therefore, repeating the cycle. HHV can also inhibit the expression of the major histocompatibility molecule I (MHC I), which displays fragments of viral proteins from within the cell to the cell surface so that the immune system can then identify and attack the infected cell. Without MHC I the cells of the immune system become practically blind for the virus. By inhibiting MHC I, HHV is allotted more time to propagate under the radar of the immune system, thus causing extensive damage to the liver. 6

Currently, there are no vaccines to combat this pathogen, however, there are medications that can decrease the propagation rate of the virus to new cells. A hypothetical antiretroviral drug called Dawilcasmer prevents HHV infection by binding to the hepatocyte receptor (DCM12-C), which unable the virus from binding to this glycoprotein and entering the host cell. HHV receptor DCM12 has to complimentary bind to a DCM12-C receptor in hepatocytes in order to enter the cell. However, this interaction gets disrupted by Dawilcasmer that acts as antagonist molecule that binds to the DCM12-C receptor, preventing the HHV from binding to the DCM12-C receptor and entering the cell. 2

Acknowledgements

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About the Author

Dawilmer Castillo is a graduating senior majoring in Biology and minoring in Biochemistry and Spanish. His research project was completed in the fall of 2014 under the mentorship of Dr. Boriana Marintcheva (Biology) and made possible with funding provided by the Office of Undergraduate Research through a course-embedded research grant. Dawilmer plans to pursue his M.D. in the fall of 2015.

Personality Traits in Parkinson's Disease

Lindsey Clark

Introduction

Parkinson's Disease (PD) is one of the most common progressive neurodegenerative diseases. It affects 1% of the world's population over the age of 65, which is approximately six million people (Parkinson's Disease Overview, 2014). The prevalence of PD ranges from 31 to 201 per 100,000 individuals. The disease occurs in all ethnic groups, affects both genders, and becomes increasingly common with advancing age. The neuropathology of PD is complex and has been linked to a variety of motor and non-motor symptoms typically exhibited by PD patients.

Common motor symptoms of PD include a resting tremor, slowness of movement, motor rigidity, and postural instability. Some of the non-motor symptoms of PD include cognitive deficits, including problems with learning and memory, visualspatial processing, and executive function abilities (i.e., working memory, planning, inhibition, attention, and speed of processing [Uc et al., 2005]). Executive function deficits are primarily associated with frontal lobe pathology (specifically, a lack of dopamine) in PD (Lees & Smith, 1983; Taylor, Saint-Cry, & Lang, 1986). There is even evidence to support the theory that certain personality differences, also associated with frontal lobe functioning, are noted between PD patients and normal control participants. One question concerns whether these noted changes in personality directly relate to the observed cognitive changes noted in PD. Only two studies to date have examined this possibility (Koerts, Tucha, Leenders, & Tucha, 2013; McNamara, Durso & Harris, 2008). Another question concerns the link between noted personality changes and disease severity. The primary purpose of the following project, therefore, is to further investigate these questions by examining the relationship between personality traits, cognitive impairments, and disease severity in PD patients.
Frontal Dysfunction in PD

PD is associated with a wide variety of cognitive symptoms that significantly impair the quality of life of affected individuals. About 80% of patients develop cognitive changes detectable by clinical evaluation during the course of the disease. Executive dysfunction is the most frequently described cognitive change in patients with PD. Other frontal lobe changes include those noted in attention, and verbal and nonverbal fluency.

Brown and Marsden (1988) used the Stroop Test to measure executive functioning deficits in PD patients. Participants were shown the words "red" and "green" written in their complementary color (e.g., the word red was written in green ink). Participants were then required to say either the color of the printed words, or the actual word itself. However, they were not always told whether to specify either the color or the word before it was shown; in some conditions they had to recall previous instruction as to which attribute was relevant. Results showed that PD participants performed significantly worse than normal control participants only when they had to remember, from previous instruction, which attribute was relevant. This executive function impairment is thought to reflect a form of set-shifting that leads to difficulty in disengaging from one task and engaging in a new task, particularly while being distracted by a previously relevant dimension (Robbins, James, & Owen, 1994).

In addition to deficits in executive functioning, PD patients show impairments on simple tests of attention (i.e,.Trails A; Stravitsky, Neargarder, Bogdanova, McNamara, & Cronin-Golomb, 2012), as well as on tests of verbal fluency (i.e., FAS; Stravitsky et al., 2012; Miller, Neargarder, Risi, & Cronin-Golomb, 2013) and nonverbal fluency (i.e., Ruff Figural Fluency Task; Stravitsky et al., 2012; Miller et al., 2013). These tests measure one's ability to attend to simple stimuli, generate words within a specified period of time, and create unique designs using basic stimuli, respectively. All are consistent with frontal lobe pathology, and are independent of other deficits such as rule-learning, working memory, or a general slowing of cognitive function. Because frontal lobe pathology is evident in PD, one question concerns whether other frontal lobe functions, such as personality traits, might also be affected by this disorder.

Personality Traits in PD

The Temperament and Character Inventory (TCI), a self-administered questionnaire developed by Cloninger, Svrakic, & Przybeck (1993) has been frequently used to assess personality characteristics in PD. It assesses seven dimensions of personality that are associated with two major components: temperament and character traits. Character traits are aspects of personality that involve individual differences in self-concepts about goals and values. Temperament traits involve differences in automatic emotional reactions and habits. The three character traits are Self-Directedness (SD): where high SD individuals have personal integrity, honor, self-esteem, effectiveness, leadership, and hope; Cooperativeness (C): where high C individuals have concepts of community, compassion, conscience, and charity; and Self-Transcendence (ST): where high ST scores display feelings of mystical participation,

religious faith, and unconditional equanimity and patience. The four temperament traits are Harm Avoidance (HA): high HA individuals are cautious, careful, fearful, tense, apprehensive, nervous, timid, doubtful, discouraged, insecure, passive, negativistic, or pessimistic and worriers; Novelty Seeking (NS): high NS individuals are quick-tempered, excitable, exploratory, curious, enthusiastic, impulsive, and disorderly; Reward Dependence (RD): high RD individuals are tender-hearted, loving and warm, sensitive, dedicated, dependent and sociable; and Persistence (P): high P individuals are industrious, hard-working, persistent, and stable (Cloninger et al., 1993).

The TCI is the preferred choice of personality assessment in PD patients because it was created based on a model relating personality traits to underlying neurobiological processes (Cloninger et al., 1993). For example, the temperament traits of NS has been shown to be directly related to dopamine levels, suggesting that damage to the mesolimbic dopaminergic system may result in low NS traits. Further, research suggests that serotonin is related to HA traits and norepinephrine to RD traits. These neurotransmitters have also been implicated in the manifestation of some of the symptoms of PD (Cloninger et al., 1993). The TCI scales exhibit satisfactory psychometric properties, are widely used in studies of clinical populations, and have been used successfully with PD patients (Menza et al., 1990; Cloninger et al., 1993; Fujii et al., 2000).

The majority of research examining personality characteristics in PD patients has found that, in general, PD patients exhibit low NS traits, high HA traits, and show less consistency in RD type-tasks than individuals without PD (Menza et al., 1990; Menza, Golbe, Cody, & Forman, 1993; Fujii et al., 2000). Poletti and Bonuccelli (2011) suggest that these noted changes, specifically the low NS and high HA traits noted in PD, are not present prior to disease onset. They believe that these personality changes are a direct result of having PD.

A question to consider is whether these noted changes in personality in PD are related to other changes manifested by the disorder. McNamara, Durso, and Harris (2008) conducted a study to examine personality, autobiographical memory, and executive cognitive function in patients with PD. Assessments used included the TCI, Stroop color-word interference, verbal fluency (FAS), and category fluency (animals). In general, they found that PD patients exhibited high HA traits when compared to normal control participants. They also reported a significant inverse correlation in their PD sample between verbal fluency scores and HA traits; the higher the HA score, the poorer the performance on the verbal fluency test.

Koerts et al. (2013) conducted a study to further investigate the relationships between executive functioning and personality traits in PD. PD and normal control participants were administered the TCI, the Stroop Color Word Test, Digit Span Backward, Zoo-Map, Frontal Assessment Battery, Trail Making Test, semantic and phonemic verbal fluency tests equivalent to the FAS test, and the Odd Man Out. Results showed that PD patients exhibited significantly higher scores on HA traits than normal control participants. However, contrary to previous literature, no differences between PD and normal control participants were noted for personality traits of NS, RD, or P. PD participants did significantly worse than normal control participants on measures of executive functioning including the Frontal Assessment Battery, semantic fluency test, and the Odd Man Out. When comparing executive measures to personality measures, significant associations were found between some of the executive measures and P and RD, but not with HA and NS. Koerts et al. (2013) concluded that in general, cognition contributes to personality traits observed in patients with neurodegenerative disorders such as PD.

Present Project
The purpose of the present project is to evaluate personality traits in PD and normal control participants, and to relate those findings to degree of PD severity and performance on frontal lobe assessments. It is fairly well established in the literature that cognition and degree of PD severity are related to one another. Multiple studies have shown that PD patients with more severe motor symptoms have a higher risk of developing more severe cognitive symptoms (Owen et al., 1992; Lees & Smith, 1983; Taylor et al., 1986; Beatty & Monson, 1990; Fama & Sullivan, 2002). It is currently uncertain, however, whether these cognitive deficits and disease severity relate to changes in personality noted in PD. This is the purpose of the current project. This study will assess personality traits in PD and relate these findings to the degree of PD severity and cognition. We will administer a variety of cognitive assessments, a personality assessment, and a disease severity assessment to examine the hypotheses of this study, which include, 1) PD participants will perform more poorly than normal control participants on all five frontal lobe assessments administered; 2) PD participants, when compared to normal control participants, will exhibit lower Novelty Seeking traits and higher Harm Avoidance traits on a personality assessment; and 3) PD participants who show deficits in cognitive abilities will also show differences in personality traits compared to normal control participants. In addition, those with higher disease severity scores will exhibit more cognitive deficits and personality changes than normal control participants.

Method

Participants

The study consisted of 50 participants: 27 non-demented PD participants (12 males and 15 females) with an average age of 64.52 years (SD = 6.24) and an average education level of 17.74 years (SD = 1.81), and 23 normal control participants (NC; 10 males and 13 females) with average age 64.35 years (SD = 6.76) and education levels of 16.78 years (SD = 2.02). PD and NC participants did not significantly differ on age [t(48) = .09, p = .93] or education [t(48) = 1.77, p = .08]. All participants scored above 25 on the Modified Mini-Mental State Exam (mMMSE), indicating the absence of dementia. PD participants scored a 28.74 (SD = 0.75) and NC participants scored a 28.70 (SD = 1.00). The mean Hoehn & Yahr staging for PD participants was 2.15 (SD = .60). The Hoehn & Yahr assesses PD severity. The average duration of PD was 5.60 years (SD = 4.09). PD and NC participants were referred from the Parkinson's Disease Center of Boston University Medical Center and local support groups, and included individuals who met the clinical criteria for mild to moderate PD as diagnosed by the patients' neurologists. NC participants were recruited from the community.

Measures and Procedures

Participants were given a battery of assessments. The assessments measured degree of PD severity andcognitive abilities, specifically executive functioning, attention, verbal and nonverbal fluency, and different personality traits.

Degree of PD severity.

Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS). PD participants were administered the Unified Parkinson's Disease Rating Scale (UPDRS; Fahn & Elton, 1987), a standard measure of symptom severity. The UPDRS has four scales. The scales are 1) non-motor experiences of daily living (13 items), 2) motor experiences of daily living (13 items), 3) motor examination (18 items) and 4) motor complications (6 items). Each subscale has 0-4 ratings, where 0 = normal, 1 = slight, 2 = mild, 3 = moderate, and 4 = severe. The total UPDRS score was used as the dependent measure. A score of zero indicates the absence of PD and a score of 400 indicates the greatest degree of PD disease severity.

Frontal dysfunction assessments.

Stroop Color-Word Task. The Stroop Color-Word Task (Stroop, 1935) is a test of executive functioning and measures selective attention, set-shifting, and processing speed. First, in the color naming condition, participants are presented with a series of "XXXXs" in five columns of 20 words. Each series is presented in one of three colors: green, blue, or red. Participants name the color of each series of "XXXXs" presented as quickly as possible. The total number correct after 45 seconds is used as the dependent measure. Next, the assessment is presented in columns with the words "green," "blue," and "red," that appear in black (the word portion of the assessment). Their task is to read the words as quickly as possible within a 45-second time frame. The total number correct is used as the dependent measure Finally, the assessment is presented in columns with the words "green," "blue," and "red," except now the words are colored such that the color of the word is incongruent with what the word says (e.g., the word "blue" appears in the color red; the color-word portion of the assessment). Participants are asked to name the color in which the words appear (the correct response to the above example would be "red"). Participants are timed and the resulting score is equal to the number correct within a 45-second time frame, which is used as the dependent measure. Lower scores indicate poorer performance.

The Delis-Kaplan Executive Functioning System (D-KEFS) Verbal Fluency Task. The D-KEFS Verbal Fluency task (Delis et al., 2001; Delis et al., 2004) measures verbal fluency, specifically, the ability to understand language rules and the ability to switch between rules. Participants were asked to generate as many words as possible that started with the letter F within a period of one minute. This procedure was repeated for the letters A and S. The results from each portion (F, A, and S) were summed to generate a total score, which was used as the dependent measure.

For the category switching portion of the D-KEFS, participants were asked to name as many pieces of fruit and furniture as possible while alternating between categories (e.g., banana, chair, peach, table, etc.) for a period of 60 seconds. The total number of words was used as the dependent measure. Lower numbers indicate poorer performance.

For the category that measures semantic fluency, the participant demonstrates verbal fluency within a given category. Participants name as many animals as possible in one minute. Individual words were counted resulting in a total score as the dependent measure, with lower scores indicating poorer performance.

The Ruff Figural Fluency Test. The Ruff Figural Fluency Test (RFFT) evaluates nonverbal fluency and mental flexibility in participants. The original assessment was a version with larger design patterns to minimize motor and visualspatial demands (Ruff et al., 1987). The test is made up of five pages, each consisting of 35 blocks of five-dot matrices, arranged in seven rows and five columns on an 8½ by 11 inch sheet of paper.

Each page consists of a different stimulus pattern of dots. The task on each page is to draw as many unique designs as possible in a one-minute interval, by connecting the dots in different patterns. The total number of unique designs, preservative errors, and an error ratio are recorded; all three scores were used as dependent measures. Lower scores indicate poorer performance.

The Trail Making Test. The Trail Making Test (Reitan, 1958) measures executive function, specifically attention and working memory (Trails A) and set-shifting or cognitive flexibility (Trails B). The Trail Making Test consists of two parts. Trails A has 25 circles with numbers (1-25) in them. Trails B has 25 circles with alternating letters and numbers (A-L, 1-13). The circles are scattered throughout the page in no discernible pattern. For Trails A, participants were asked to draw a line as quickly as they could, connecting all of the circles in numerical order without lifting the pen. The amount of time it took to connect all of the circles was recorded and used as the dependent measure. For Trails B, participants were asked to connect the circles in order, alternating between letters and numbers (1, A, 2, B, etc). The amount of time it took to connect all of the circles was recorded and used as the dependent measure. Lower time indicates better performance.

The Wisconsin Card Sorting Test (WCST) The Wisconsin Card Sorting Test was used to assess set-shifting and preservation (Kongs et al., 2000). The WCST version used for this study was the 64 Cards Computer Version. The purpose of the test is to assess the ability to form abstract concepts, to shift and maintain sets, and to utilize feedback. The tests consists of four stimulus cards, placed in front of the participant, the first with a red triangle, the second with two green stars, the third with three yellow crosses, and the fourth with four blue circles. The participant is then given two decks, each containing 64 response cards, which have designs similar to those on the stimulus cards, varying in color, geometric form, and number. The participant is told to match each of the cards in the decks to one of the four key cards and is given feedback after each trial. The computer assessment changes the sorting rules after a set number of trials and the participant needs to figure out that the rules have changed based upon the feedback he/she receives. For the purposes of this project, the number of categories completed was used as the dependent measure. Lower scores indicate poorer performance.

Personality assessment.
Temperament and Character Inventory (TCI). Participants were asked to complete the Temperament and Character Inventory (TCI), a self-report questionnaire consisting of 240 items. As described earlier, the TCI examines seven different dimensions of personality traits, including four so-called temperaments: Novelty Seeking (NS), Harm Avoidance (HA), Reward Dependence (RD), and Persistence (P), and three so-called characters: Self-Directedness (SD), Cooperativeness (CO), and Self-Transcendence (ST) (Cloninger et al., 1993). Each item is rated with a two-point scale: "True" (1) or "False" (0). Each subscale assesses opposing qualities. For example, one subscale of NS is "Exploratory Excitability vs. Stoic Rigidity." All seven TCI trait scores were included as dependent measures.

Results
Hypothesis 1
PD participants will perform more poorly than NC participants on all five frontal lobe assessments administered.

Stroop Color-Word Test. Independent samples t-tests were performed to examine group (PD, NC) differences on the three conditions of this assessment: color naming, word, and color-word. Results revealed a significant difference in the color naming condition, $t(48) = 2.09$, $p<.04$, and the word condition, $t(48) = 2.82$, $p< .007$, but not in the color-word condition, $t(47) = 1.87$, $p = .07$, although the result may be considered a trend. In each condition, the PD participants performed worse than the NC participants.

D-KEFS. Independent samples t-tests were performed to examine group (PD, NC) differences on the three conditions of this assessment: FAS total, switch fruit/furniture, and animals. Results revealed no significant group differences in the FAS total, $t(48) = .93$, $p = .36$, switch fruit/furniture, $t(48) = .74$, $p = .46$, or the animals condition, $t(48) = 1.22$, $p = .23$. PD participants did not exhibit any deficits on this assessment. RUFF. Independent samples t-tests were performed to examine group (PD, NC) differences on the three measures of this assessment: total number of unique designs, number of errors, and perseveration errors. Results revealed no significant difference in the total number of unique designs, $t(48) = .52$, $p = .61$, the number of errors, $t(48) = 1.25$, $p = .22$, or in perseveration errors, $t(48) = 1.24$, $p = .22$. PD participants exhibited no deficits on this assessment.

Trails A and B. Independent samples t-tests were performed to examine group (PD, NC) differences on the two conditions of this assessment: Trails A and Trails B. Results revealed no significant difference on Trails A, $t(48) = 1.50$, $p = .14$. There was a significant difference on the Trails B condition, $t(46) = 2.02$, $p<.05$. Here, PD participants performed worse than the NC participants.

WCST. Independent samples t-test were performed to examine group (PD, NC) differences on the number of categories

completed. Results revealed no significant difference in the number of categories completed, t(48) = 1.25, p = .22. PD participants exhibited no deficits on this assessment.

Hypothesis 2
PD participants, when compared to NC participants, will exhibit lower Novelty Seeking traits and higher Harm Avoidance traits on the TCI. Independent samples t-tests were performed to examine group (PD, NC) differences on the four temperament traits (NS, HA, RD, P) and the three character traits (SD, C, ST) of the TCI. There were no significant differences for any of the temperament traits (NS: t[48]= .001, p = .99; HA: t[48] = .78, p = .44; RA: t[48] = .51, p = .62; P: t([48] = 1.04, p = .31). For the character traits, there was a significant difference for Cooperativeness: t(48) = 2.16, p<.04, but not for SD: t(48) = 1.09, p = .28, or ST: t(48) = .86, p = .40. PD participants scored higher in cooperativeness than NC participants.

Hypothesis 3
PD participants who show deficits in cognitive abilities will also show differences in personality traits compared to normal control participants. In addition, those with higher disease severity scores will exhibit more cognitive deficits and personality changes. In regards to disease severity, PD participants exhibited a mean of 30.08 (SD = 9.67) on the UPDRS. This value is consistent with mild severity PD impairments

NC correlations. Pearson correlations were performed to examine the relation between disease severity, cognitive variables, and personality traits. Alpha was set to .01 to account for the large number of correlations performed. Correlations for the NC group revealed significant relations between RD and color naming measures: r(23) = -.56, p<.006 and between NS and the number of errors on the RUFF: r(23) = .54, p<.007. Specifically, individuals who exhibited higher RD traits performed better on the color naming measure and individuals who exhibited higher NS traits exhibited more errors on the RUFF.

PD correlations. Pearson correlations were performed to examine the relation between disease severity, cognitive variables, and personality traits. Alpha was set to .01 to account for the large number of correlations performed. Correlations for the PD group revealed no significant relations between any of the dependent measures.

Discussion
Overall, the results of the current project do not reflect general findings demonstrated by previous literature. Potential reasons for this discrepancy are discussed following a summary of the

results for each of the three stated hypotheses.

The first hypothesis predicted that PD participants would perform more poorly than NC participants on all five frontal lobe assessments. Results demonstrated that PD participants only exhibited deficits on the color naming and word conditions of the Stroop, and Trails B. No deficits were noted on the color-word condition of the Stroop, Trails A, the D-KEFS, the RUFF, or the WCST. Only some of these findings are consistent with previous literature. For example, Stravitsky et al. (2012) and Miller et al. (2013) found that PD participants performed poorly on Trails A and B, Verbal Fluency (FAS), and RUFF Figural Fluency when compared to normal control participants. Roca et al. (2012) and Liozidou, Potagas, Papageorgiou, & Zalonis (2012) also found that PD participants performed significantly poorer on the WCST. In sum, although PD participants in the current study did exhibit deficits consistent with previous literature (such as on the Stroop and Trails B), their impairments were not as extensive as those typically reported (i.e., showing deficits on most if not all of the frontal lobe type assessments).

The second hypothesis predicted that PD participants, when compared to normal control participants, would exhibit lower Novelty Seeking traits and higher Harm Avoidance traits on a personality assessment. Results demonstrated that PD participants did not exhibit lower Novelty Seeking traits nor higher Harm Avoidance traits, but they did exhibit higher scores in Cooperativeness traits. These findings are not consistent with previous literature. Specifically, Menza et al. (1990; 1993) and Fujii et al. (2000) found low Novelty Seeking and high Harm Avoidance traits in PD participants on the TCI. Koerts et al. (2013) found that their PD sample only showed significantly higher scores on Harm Avoidance traits but not Novelty Seeking traits. McNamara et al. (2008) looked at Cooperativeness traits in PD participants. However, unlike the current study, PD participants did not show any significant results on Cooperativeness traits. In sum, the results of the current study did not find the low Novelty Seeking and/or high Harm Avoidance trait pattern in PD patients noted in the literature.

According to the third hypothesis, it was predicted that PD participants who show frontal lobe dysfunction would also show differences in personality traits compared to normal control participants. In addition, PD participants with higher disease severity scores were expected to exhibit more cognitive deficits and personality changes. Correlations for the PD group revealed no significant relations between cognitive dysfunction, personality assessments, or degree of severity. This is inconsistent with the previous literature that has found

significant correlations between executive function measures and Persistence and Reward Dependence personality traits in PD participants (Koerts et al., 2013).

Sample Characteristics

As demonstrated by the findings, many of the published cognitive deficits and personality changes observed in PD patients were not observed in the current study. One possible explanation relates to the characteristics of the participant sample used. Specifically, the sample of PD participants used in the current study is higher functioning in regards to PD severity than samples published in the literature and higher than those that have participated in our previous research studies. Atypical participant recruitment procedures biased the sample by only including the highest functioning PD patients and those with the lowest disease severity scores in the research study. Once the bias was discovered, the method of recruitment was terminated. Had the normal routine recruitment strategies been implemented, PD patients with a range of abilities and disease severities would have been recruited, which is more representative of the population, and different findings may have resulted.

General Limitations

There are some limitations to the current study. First, a relatively small sample size was used, and as noted above, the sample was most likely biased. Second, it is unclear whether the assessments used in the current study, both cognitive and personality, are the most sensitive to detecting impairments in PD patients. Other assessments may prove to be more useful and should be explored. For example, the Big Five Personality Test could be used. The third limitation is that this PD sample was highly educated. PD participants reported 17.74 years (SD = 1.81) of education, which is equivalent to having a master's degree. Some of the participants even had doctoral degrees. This sample, therefore, may not be representative of the general PD population. An explanation as to why this pattern occurred is that highly educated PD participants may be more motivated to participate in research studies than those who are less educated. This observation may also relate to the current study's finding that PD participants reported more Cooperativeness traits. It would be interesting to see if Cooperativeness traits were evident in the general PD population and not just in those individuals motivated to participate in research. The fourth limitation relates to the examination of gender differences. A preliminary analysis of the current data suggests that there may be gender differences in personality traits in PD participants. Specifically, PD females reported higher levels of Reward Dependence than did PD males or normal control females. PD females also reported higher levels of Cooperativeness than did normal control

females. These findings extend the literature on personality in PD by documenting the relation of gender to temperament and character profiles. Future research should therefore include gender as a variable of interest.

Conclusion

The current study examined the relationship between personality traits, cognitive impairments, and disease severity in PD. Although some impairments in cognitive performance were noted, and PD patients exhibited higher degrees of Cooperativeness personality traits than normal control participants, the results were not generally consistent with previous literature, most likely due to a biased PD sample. By continuing to examine the range of non-motor deficits associated with PD, we hope to aid in developing interventions aimed at improving the quality of life of these individuals.

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About the Author

Lindsey Clark graduated summa cum laude from Bridgewater State University in May of 2014 with a bachelor's degree in Psychology. Her research project was completed in the spring of 2014 under the mentorship of Dr. Sandra Neargarder (Psychology). The project was made possible with funding provided by an Adrian Tinsley Program summer research grant and semester grant. Lindsey presented this paper at the 2014 Cognitive Aging Conference in Atlanta, GA. She plans on continuing her education by pursuing a Master's degree.

The Online Sex Sting

Michael Cryan

Society and the media have created a popular and sensationalized profile of the American sex offender. In dramatization, offenders are often portrayed as white, middle-aged, single and male; in actuality, sex offenders are a much more complex group of individuals. Research on this large, profoundly heterogeneous mix has attempted to sort offenders into schemas based upon their type of offending (Robertiello & Terry, 2007). Regardless of their classification, however, perpetrators can be male, female, straight, gay, bisexual, married, single, and of any race or economic status.

One of the sex offender subgroups created by Robertiello and Terry is that of online predators. This type of sex offender uses the internet to collect child pornography and solicit underage children for acts of sex. As with other sex offenders, online perpetrators can be vastly different from one another, and some may be more dangerous than others. In an effort to combat both child pornography and online solicitations police departments, under the mandate of the United States government, have engaged in undercover internet sex stings. These stings work to capture online offenders before they meet any underage person in the physical world. However, the continuation of their use has called both their efficacy and morality into question. This paper will examine in detail who is targeted, how the stings are implemented, and whether or not they act as a form of "net-widening" among the online sex offender population.

Chapter 265, Section 26C of the General Laws of the Commonwealth of Massachusetts states that anyone who entices a child under the age of 16 shall be punished by imprisonment in the state prison for not more than five years, or in the house of correction for not more than two-and-a-half-years, or by both imprisonment and a fine of not more than $5,000. Within this law, the term "entice" is legally defined as "lure, induce, persuade, tempt, incite, solicit, coax, or invite" (Mass. Gen. Laws Ch. 265, § 26C, 2014). In layman's terms, this definition includes conduct constituting criminal sexual abuse of a minor, sexual exploitation of a minor, or a similar offense (Child Enticement & Exploitation, n.d.).

Section A: Background & Data

Public fear of online sexual solicitations targeting minors resulted in the design of the Youth Internet Safety Survey in 2000 (Mitchell, Jones, Finkelhor, & Wolak, 2013). Since its inception, the survey has been conducted at five-year intervals. Solicitations as defined by and studied in the survey ranged from benign interrogatives (i.e. "What's your bra size?") to cases that pose a high risk of sexual assault occurring offline. The Youth Internet Safety Survey has been conducted at five-year intervals since its inception in 2000. These studies are indicative of an incredibly small subset of solicited minors that have had sexual contact at meetings occurring offline.

The number of solicited youth stood at 1% in the 2010 study (Mitchell, Jones, Finkelhor, & Wolak, 2013). The three YISS studies have also indicated that girls and older youth (aged 15 to 19) are at a higher risk of receiving online solicitations than boys and younger youth. Overall, however, the occurrence of the enticement of youth actually appears to be on the decline in recent years (Wright, 2014), although instances of online aggressive sexual solicitation increased between 2000 and 2005 (Mitchell, Finkelhor, & Wolak, 2007). In 2000, 19% of youth aged 10 to 17 received sexual enticement, while in 2005, this statistic decreased to 13%. By 2010, the number had dropped to 9%. This decline is a result of a reduction in youth who were being asked to talk about or disclose sexual information online (Mitchell, Jones, Finkelhor, & Wolak, 2013). The decline is truly compelling given the marked increase in youth internet activity during the decade of the 2000s (Mitchell, Jones, Finkelhor, & Wolak, 2013). Such a decline may have occurred as a result of changes in youth usage of the internet, widespread dissemination of internet safety resources, or an increase in online law enforcement activity.

Section B: Research on the Policy

The objective of the internet sex sting operation is, through the use of police deception, to arrest those adults who have been seeking a sexual relationship with a minor. In these cases, law enforcement acts under the guise of a minor in order to draw out the offender. The stings should, theoretically, prevent the offender from having future contact with minors and serve as a deterrent to other potentially deviant members of the online community. Rulings in the United States have allowed law enforcement agencies to conduct internet sex stings, and several other parts of the world have been following suit (Wright, 2014). However, there is data that suggests that law enforcement has been reducing its usage of online stings. In the third YISS, a decrease in the number of arrests made via an internet sex sting was reported. Because of the decline, it has been suggested that law enforcement have shifted their focus to instead target child pornography (Wright, 2014).

The demise of NBC's To Catch a Predator in 2007 is perhaps another contributor to the decreased usage of internet sex stings. The show revealed that Louis Conradt, a suburban Dallas prosecutor, had engaged in sexually explicit chats

online with an adult posing as a minor (Gold, 2008); soon after he committed suicide. As a result, Conradt's sister, Patricia Conradt, filed a $105 million dollar lawsuit against NBC stating that the actions of To Catch a Predator directly caused her brother's suicide. NBC Universal and Patricia Conradt settled for an undisclosed amount after it was determined that the suicide was foreseeable, that law enforcement should have protected Conradt, and that NBC acted with deliberate indifference (Gold, 2008). It is conceivable that a rollback of police usage of the internet sex sting was due in part to the bad taste left in the mouths of the public following To Catch a Predator's collapse.

In the cases that the undercover stings are meant to target, an offender arranges a physical meeting with a minor, presumptively for a sexual reason. However, a second type of offender that is commonly conflated with the "contact" offender is the "fantasy-only" offender. The "contact" offender is a bona fide predator, who commonly has a history of child sexual abuse. The "fantasy-only" offender is another subgroup whose behavior does not extend beyond the collection of child porn for the purpose of masturbation (McCarthy, 2010).

Sexual offenders are, clearly, a heterogeneous group, but the laws often lump the two different groups of offenders together. This grouping is based on the "harm thesis," which states that looking at porn causes men to commit sex crimes (McCarthy, 2010). Of course, the data that has been collected on child sex crimes paints a different, very complex picture. Recidivism data on 201 offenders over a two-and-a-half-year period suggests that offenders who had child pornography charges did not go on to commit a contact offense during the follow-up period. In addition, in a survey of 290 "boy-attracted pedosexual males," 84% of anonymous respondents reported that viewing child porn involving boys replaced the need to be with an actual child, and 84.5% reported that viewing the erotica did not increase their likelihood to molest a boy (McCarthy, 2010).

Contrary to both popular belief and public perception, there is no standard "profile" of a sex offender. However, in two studies cited by McCarthy, antisocial orientation was found to be significant in sample populations. Also contained within sample sets of sex offenders was a history of contact with mental health services (41% of offenders) and a history of major depression (21% of offenders). Offenders who are arrested as a result of proactive policing, namely, internet sex stings, often try to justify their deviant behavior through three distinct cognitive distortions—refutation, minimization, and justifications/rationalizations (DeLong, Durkin, & Hundersmarck, 2010).

Minimization is defined as a denial of the extent to which the offense occurred or a denial of the intent to commit an offense at all (ultimately, a denial of responsibility). Justification/rationalization refers to the offender devising an inaccurate yet self-satisfying reason for their behavior, such as denying that the victim was harmed or that the act was inherently immoral. And finally, refutation refers to a full, outright denial of the offense. A study of 18 sex offenders by DeLong, Durkin, and Hundersmarck confirms that child sexual abusers have distorted cognitions regarding the nature of their sexual conduct. The men in the study either claimed ignorance as to the age of the fictitious minor (this study having been conducted via stings) or attempted to deny sexual motivation for traveling to meet a minor.

Section C: Unintended Consequences and/or Alternatives

The use of the internet sex stings by police as a method for snaring sex offenders online has inherently encouraged the use of police deception. In addition, the stings are predicated on the assumption that a crime was imminently going to occur, and the enticement charge becomes punitive on what might happen. Sex offenders who are charged with online enticement commonly use defenses such as free speech, police entrapment, factual impossibility, and egregious government conduct. For the purposes of this paper, the entrapment and factual impossibility defenses as they relate to the use of online stings will be closely examined.

The basic premise of the entrapment defense is that the crime (in this context, the enticement of a minor) would not occur without the behavior of the government (the usage of a sting), but the subtleties and nuances of this defense are much more complex. The defendant in a case of alleged entrapment argues that the police officers induced the defendant to engage in an act of criminality that they, of their own free will, would not commit otherwise. The courts have allowed the usage of undercover sting operations through case law such as Sorrells v. United States (1932) and United States v. Russell (1973) (Peters, Lampinen, & Malesky, 2013). It lies on the defense to prove that the defendant lacked predisposition.

In a study conducted by Peters, Lampinen, and Malesky, a mock trial was established simulating the proceedings of an enticement case. It was found that jurors in the mock trial were less likely to rule the defendant guilty if the action of solicitation was initiated by the undercover police officer. However, jurors who claimed to have a higher crime control orientation were more likely to charge the defendant with the crime regardless of the legality or fairness of the procedure, while those with a higher due process orientation were more likely to scrutinize the legality and means by which the offender

was caught (independent of the crime itself) and exonerate the defendant (Peters, Lampinen, & Malesky, 2013). Implications of this study include the adequate training of agents engaging in undercover sex sting operations in order to avoid procedural pitfalls, and consideration, by both prosecutors and the defense, of the initiator of the sexual solicitation.

The impossibility defense is another option available for the defendant to use in the case of an online sting. This particular defense may be used when "the actions which the defendant performs or sets in motion, even if carried out fully as he desires, would not constitute a crime" (Congressional Research Service, 2011). Factual impossibility may exist when the objective of the defendant has been knowingly criminalized by the law, but an element of the case unknown to the defendant would prevent him from accomplishing the objective of the crime (in the case of online sex stings, there is no child to assault—therein lies the factual impossibility). Several states have specifically refused to recognize an impossibility defense of any kind, and attempt, as defined by the Model Penal Code, to include instances when the defendant acted with the intent to commit the offense and acted in a way that would lead to a crime if the offender's circumstances and the circumstances of the situation were as he had believed them to appear. The intricacies of both the entrapment and the factual impossibility defenses, as well as the established case law of the nation, allow for the overall permissibility of the internet sex sting

Raphael Cohen-Almagor cites four different sources that can take responsible action to prevent online predators from reaching and enticing these minors: parents, the educational system, Internet Service Providers, and other business companies. Products such as Net Nanny and Surf Watch are easy to configure and affordable, and will allow parents to screen everything that is passing through a computer (Cohen-Almagor, 2013). Schools can also aid in disseminating information about legitimate and illegitimate modes of sexual behavior to help young people deal with their normative and healthy curiosity about sex. Schools can offer preventative messages about the online advances of inexperienced youth that stem from dangerous adults. Internet Service Providers can be diligent in policing their interest groups and swiftly closing those that do not conform to normal behavior or legal sex-oriented topics.

Social networking sites have also taken it upon themselves to monitor their networks for inappropriate content, such as child pornography, in the name of trust and healthy business (Cohen-Almagor, 2013). Online spaces are modes by which trusting and close relationships are often established, and are proactively monitored using instruments such as image-scanning technology and other types of software. American Internet Service Providers are required to report incidences of child pornography to the National Center for Missing and Exploited Children, who will, in turn, involve law enforcement (Cohen-Almagor, 2013). This relationship between the ISPs and NCMEC is cooperative and is good for the business of the ISPs for obvious reasons.

Third-party businesses often comply with entities such as the NCMEC in order to block the flow of child pornography and prevent their companies from making money via immodest means (Cohen-Almagor, 2013). Credit card companies like MasterCard, Visa, American Express, and Discover cooperate with NCMEC through methods such as the Financial Coalition Against Child Pornography, which aims to block online monetary transactions related to the distribution of child porn. In the event of a criminal investigation, companies will attempt to track sellers and buyers. Although these initiatives have caused some successful disruptions in the circulation of child pornography, they have also caused a resultant shift of offenders toward less recognizable payment brands and methods.

Vigilantism against online sex offenders, in conjunction with undercover police stings, has also occurred. In the case of Perverted Justice, the vigilantism has been publicly glamourized. According to their website, they are a secular, not-for-profit organization that pursues and actively seeks to punish online sex offenders. Perverted Justice, or PJ has worked with law enforcement to conduct stings and collect evidence against sex offenders online ("Frequently Asked Questions," 2008). PJ has been involved with NBC's To Catch a Predator as well as large-scale sting operations conducted by law enforcement. Although vigilante groups such as PJ have garnered a degree of public support, they are not an official, publicly-funded government entity. However, they do have a financial investment in the capture of online sex predators.

Section D: Conclusion and Unresolved Questions
As a form of proactive policing and sexual assault prevention, I do not support the use of undercover, online sex sting operations. This type of policing activity is a form of "net-widening" in the criminal justice system. It is supported by the need for preventative arrest and conflates truly dangerous people with those who engage in sexually deviant behavior but would never harm a child. The use of an undercover sting is prone to punish people for their thoughts, not their actions. Undercover stings actually disrupt the criminal justice system, turning it from adversarial, where the court serves as an impartial referee between the prosecution and the defense, to inquisitorial, where the court or a part of the court is actively

involved in investigating components of the case. The court loses impartiality and becomes a third and active player in a case. Hypothetically, the government can change the rules at their own disposal.

During a judicial proceeding, perjury is defined as the offense of willfully telling an untruth after taking an oath or swearing an affirmation. Thus, those involved in a court case are legally bound by their word. However, before the case ever reaches a court, a police officer, through the use of police deception, engages in a government-sanctioned act of lying. Police officers are taught and encouraged to utilize deceptive practices, and are rewarded for success (Alpert and Noble, 2009). This behavior creates a double standard within the legal and criminal justice systems.

In their study, Alpert and Noble cite a "deceptive continuum" that exists within the policing of our society. At one end of this continuum are the excusable and justifiable lies (which are made in jest or defendable based on circumstances), and on the other end is malicious, intentional, and deceptive conduct. Such conduct includes deceptive action in a formal setting (i.e. in court or during an investigation), observing the so-called "code of silence" between police officers, and the creation of false evidence against a defendant. Any conduct of this kind will permanently destroy an officer's credibility. As the researchers note, however, these deceptive practices on the behalf of the police are unlikely to cease.

An argument against the use of deception is the possibility that it may be used in other situations. If undercover officers are rewarded for the successful deception of the American public, what prevents them from expanding the use of deception to elicit other results, such as a false confession, that would help them succeed personally or professionally? The courts have upheld the notion that officers can use deceit to elicit a confession so long as their actions do not "shock the conscience" of the court or would otherwise impel an innocent person to wrongfully confess (Alpert & Noble, 2009). It could be argued that by encouraging deceit in these situations, the courts may be viewed as hypocritical.

As one who hopes to become a parent, I sympathize with the desire to protect children from dangerous adults. The presence of sexually deviant men in online chat rooms geared toward young people is, statistically speaking, not the problem at large when it comes to preventing sex crimes. 60 to 80 percent of sexual assaults occur within the context of a pre-existing relationship (Wright, 2014), but the laws in the United States are tailored to the image of a "super-predator" who is white, unmarried, and grooms unsuspecting kids in chat rooms

before kidnapping and raping them. If we, as Americans, want to alleviate the problem of sex crimes, we need to examine the true heart of the issue at hand.

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About the Author

Upper Limb Ambidexterity in the Wrestling Snap Down Technique

NICHOLAS DeCASTRO

Introduction

Wrestling is a sport of antiquity, popular throughout recorded history. Egyptian and Babylonian reliefs from 3000 BCE, records in India from 1500 BCE, Chinese documents from 700 BCE, and Japanese texts from the 1st century BCE all attest to its popularity (Augustyn, Chauhan, Cunningham, Lotha, Shepherd and Young, 2014). Wrestling became infamous in ancient Greece. It was well established by the first Olympic Games in 776 BC (Augustyn et al., 2014). With the decline of Greek culture and rise of the Romans, wrestling was adopted by Romans but without the popularity and brutality of the Greeks. When the Roman Empire crumbled, references to wrestling all but vanished from European documents until approximately 800 CE (Augustyn et al., 2014). Wrestling made the voyage to the New World with the first settlers from England. Colonists also found wrestling quite popular among the Native Americans. Only the catch-as-catch-can style survives from colonial times, and it has evolved into the modern form of collegiate wrestling (Augustyn et al., 2014). New York City held the first national wrestling tournament in 1888; Saint Louis became the site of the first wrestling competition in the modern Olympic Games in 1904. The first NCAA Wrestling Championships officially began in 1912 in Ames, Iowa ("History of Wrestling", n.d).

Folk style wrestling, also known as collegiate wrestling, is a subdivision of the sport most popular in the United States' high schools and universities. It differs from other forms because the focus is on wrestlers learning to control their opponents rather than developing explosive action. There are also rules specific to this style. To avoid injuries, wrestlers are discouraged from throwing their opponents ("The History of NCAA Wrestling", n.d). The length of each period is also different, with the first period three minutes in duration while the second and third periods are only two minutes apiece. Another rule unique to Folk style is riding time. It refers to the scoring system, which states that if a wrestler stays in the top position for more than a minute, the athlete is awarded an extra point ("The History of NCAA Wrestling", n.d).

Within Folk style wrestling, pinning is achieved and points accrued through the technical and skilled application of a variety of moves and motions. One such move is the snap down technique. It is a basic skill taught to all wrestlers, yet its successful execution can determine the outcome of a match. It involves tying up with the opponent, one arm behind the opponent's head with the opposite hand gripping one of their triceps (Hamel, n.d). The wrestler then executes an explosive "snap" motion with both arms, as if to spike the opponent's head into the mat. Simultaneously, the wrestler is launching their feet behind them in a sprawling position to gain additional power in snapping the opponent's head down (Hamel, n.d). If performed correctly, this rapid motion will cause the opponent to stumble toward the ground. In the event that the opponent drops to their knees, the wrestler then quickly circles behind to secure points (Hamel, n.d). If not, the maneuver is repeated to produce the desired result. Certain opponents are difficult to topple with this motion, but it can still be used as a strategic intimidation tool in preparation for a different take down wrestling move. By snapping them forward, the opponent's reaction is to pull back and up, thereby exposing their legs for a follow up shot (Hamel, n.d).

The importance of ambidexterity in wrestling should not be underappreciated. During a match, the ability to perform a technique, such as the snap down skill, on either side of the body can swing the outcome in one's favor and determine victory or defeat. Wrestlers should be taught how to perform all wrestling techniques from both sides; if an opponent is preventing a right-sided striker from launching a takedown maneuver, a wrestler who possesses the ability to execute the move on the opposite side can surprise the opponent. Often, the likely result is a win for the wrestler. However, the question of proper performance of the snap down skill is not well understood. There is a lack of scientific literature that examines the mechanics of wrestling skills in the field of sports biomechanics. Much of the literature has examined the sport of wrestling in a number of different ways: from a psychological perspective, such as the mental perception of wrestling (Leng, Kang, Lit, Suhaimi, and Umar, 2012), the efficacy of wrestlers' technique in relation to their body measurements and motor coordination (Cvetkovic, Maric and Marelic, 2005), and the effect of various coaching styles on wrestling performance (Polansky, 1999). Yet none have examined the sport from a biomechanical perspective.

In sports such as rugby and soccer there have been studies conducted to examine the kinematics of particular skills. Dorge, Andersen, Sorensen and Simonsen (2002) examined the mechanics and kinematic variables of instep soccer kicking between the dominant and non-dominant legs of seven skilled
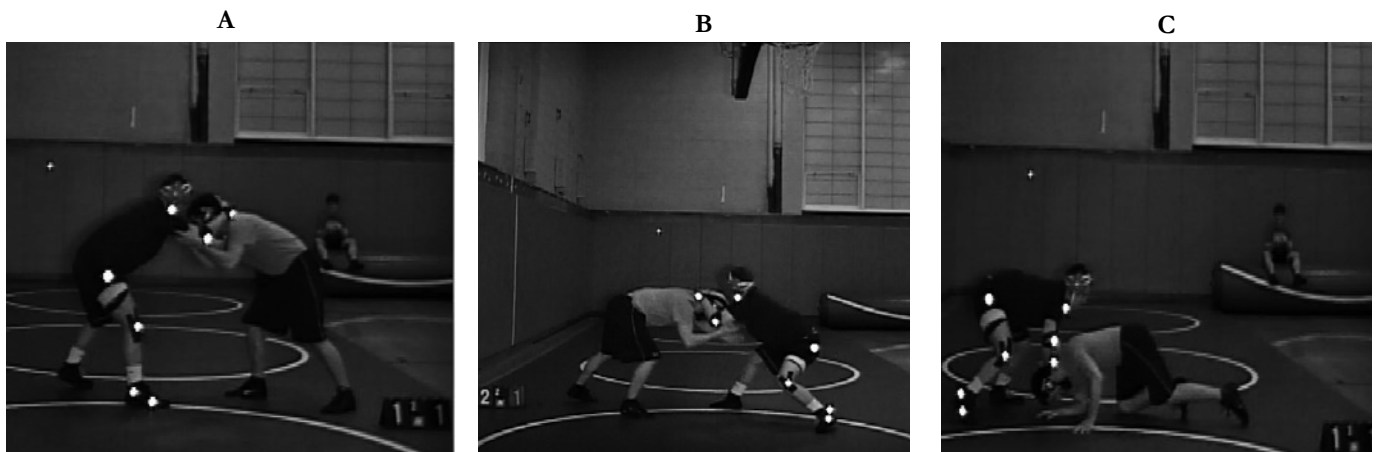
Figure 1: The progression of the snap down technique from the right side: A) start position, B) executing, and C) finish position.

Figure 2: The progression of the snap down technique from the left side: A) start position, B) executing, and C) finish position.

soccer players. Prior to testing, 30 skilled players were asked to kick a ball eight times with each leg. A Doppler radar gun was used to measure ball velocity. The research team then selected seven players with the most constant ball velocity using both legs for participation in the study. Each participant was asked to perform three instep place kicks on a stationary ball at full speed, using both dominant and non-dominant legs. Testing randomization was utilized between trials. The authors found that the ball's velocity was higher with the dominant leg due to higher foot velocity from a smoother, more fluid motion during kicking technique. A study by Ball (2011) evaluated the skill of drop punt in seventeen professional male rugby players between the dominant/preferred and non-dominant/non-preferred legs. The researchers collected kinematic data of the kicking leg and pelvis from the time of toe off until ball contact. The authors found that hip range of motion, angular velocities of the knee, shank and foot were higher in the dominant leg, while hip and thigh angular velocity of the non-dominant leg were greater at the point of contact with the ball. The conclusion was that when using the dominant leg the participants utilized the knee, shank and foot to a greater degree, whereas with the non-dominant leg the hip and thigh

had greater emphasis.

The study of the snap down technique in wrestling remains to be addressed. It is necessary for every wrestler to develop and master it properly to be successful and victorious. By studying the kinematics of the snap down technique, as well as the differences between execution by dominant and non-dominant limbs, coaches and athletes will gather very useful information. The information will result in improved technique effectiveness in matches and a reduction of the incidences of injury. By educating athletes in the implications proper joint angle, velocity, and acceleration have on human body structures, one can better instruct them on how to correct form through the use of visual aids. Finally, due to the lack of literature on ambidexterity, understanding bilateral movements in sport skills will advance the body of knowledge in the field of sports biomechanics. Therefore, the purpose of this study was to examine the kinematic motion of the shoulder and elbow joints, between the dominant and the non-dominant arms, during the execution of the snap down technique. The researcher hypothesized that the results would reveal a significant difference from one side to the other, particularly

with the motions of the shoulder joint.

Methods

Six male collegiate level wrestlers were recruited from two different universities, to participate in this study. The mean age, height and weight were 20 ± 2 yrs., 1.8 ± 0.1 m, 68.2 ± 13.6 kg. All participants were free of injury or illness, and they used their right arm/leg as their dominant side and left arm/leg as their non-dominant side. Both approval from the institutional review board and informed written consent were obtained prior to the beginning of the study. Testing was conducted in the university wrestling room. Each participant was instructed to warm up as he would normally before practice or competition. Reflective joint markers were placed on both sides of the body at the base of the 5th metatarsal, lateral malleolus, lateral aspect of the knee joint, greater trochanter, acromion process, lateral epicondyle, and the ulnar styloid process. Regulation headgear, wrestling shoes and mouth guards were used to simulate the movements in real match and to ensure athlete safety. Participants were instructed to begin in neutral position (standing) and perform a total of ten snap downs. Five snap downs were conducted with the dominant (right) arm in the controlling position (posterior neck), and another five snap downs with the non-dominant (left) arm in the controlling position. The order of execution (right vs. left) was randomized to reduce the order effect. To ensure the consistency of the data the same opponent was used for all six male wrestlers. A one-minute rest period was afforded between each snap down and a five-minute rest between each arm. A standard two-dimensional kinematics analysis was conducted with a camera set up to capture the sagittal view of the snap down motion. Trials were recorded using a JVC video camera (Model: GR-D371V) captured at 60 Hz in conjunction with a 650W artificial spot light. Kinematic motion of the shoulder and elbow joints was analyzed with the Ariel Performance Analysis System (APAS). The digital filter was applied to the data with the cut off frequency of x = 7 and y = 7. A twin sample t-test was conducted at α = 0.05 to examine the kinematic variances between the right and left arms, and all statistical analyses were conducted with SPSS (v. 18)

Results

A paired sample t-test (n = 6) was conducted between the right side and left side snap down execution. The angular displacement, velocity, and acceleration of the elbow and shoulder, were analyzed using a dependent sample t-test (p < 0.05).

Table 1: Angular Displacement Between Right and Left Side Snap Down

Body Kinematic Variables	Right vs Left Mean (SD)$^\circ$	p
Shoulder	38.8 (17.6) vs 44.9 (26.5)	.55
Elbow	113.2 (32.1) vs 123.2 (30.06)	.09

Table 2: Angular Velocity between Right and Left Side Snap Down

Body Kinematic Variables	Right vs Left Mean (SD)°/s	p
Shoulder	36.4 (70.1) vs 180.4 (231.8)	.16
Elbow	178.6 (203.4) vs 312.5 (432.8)	.51

Table 3: Angular Acceleration Between Right and Left Side Snap Down

Body Kinematic Variables	Right vs Left Mean (SD)°/s^2	p
Shoulder	915 (1020.5) vs 269.8 (2514.9)	.58
Elbow	951.3 (2377.6) vs 927.5 (4188.8)	.99

The results showed no statistical difference between right and left sides in any of the tested parameters.

Discussion

Folk Style Wrestling is a sport that has received very little attention from the research community. The purpose of this study was to examine the snap down technique, specifically the joint angular displacement, velocity and acceleration of the shoulder and elbow as the wrestler executed the technique using the right (dominant) and left (non-dominant) sides. Data collection was initiated at the moment that the participant began his technique and concluded when they had reached the lowest position, or "end" point, in the technique. Each trial was approximately one second in duration with slight deviations. Elbow joint angle was measured using the wrist and shoulder reflective markers; shoulder joint angle was measured using the elbow and hip reflective markers. The results of the study revealed that there was no statistical significant difference in any

of the three parameters when compared bilaterally. Despite an exhaustive search of multiple research databases, no research studies of a similar nature and purpose were discovered. Therefore, the researchers expanded their search to include studies involving a wider diversity of sports but with similar objectives regarding ambidexterity and bilateral limb analysis.

Čular, Miletić and Miletić (2010) examined the influence of limb dominance on the performance of specific motor abilities of Taekwondo skills. Thirty-nine male and eighteen female participants, with a mean age of 10 ± 2 years were tested on two separate occasions to evaluate their ambidexterity when executing the front kick and roundhouse kick. The results revealed a significant difference in motor ability when assessing frequency of alternate leg movements in both genders, while assessment of flexibility, strength and explosive power in the leg did not show any significant difference between genders. A higher ambidexterity in the male population was noted but did not represent a significant difference between the populations. For male athletes, the researchers indicated that motor abilities and technique performance had a strongly defined linear correlation (.75 to .81) on both the left and right side. In female athletes, no such significant correlation was made.

Trial & Wu (2013) conducted a study examining the differences in the joint angular displacement, velocity and acceleration of the hip, knee, ankle joints between the double-collar tie and double underhook positions in Thai Boxing. Participants executed six continuous knee strikes with the dominant leg (right) in each of the two clinching positions for a total of twelve knee strikes. Data was collected from the athlete's starting position until strike contact. The results revealed a statistical significant difference in the hip angular displacement ($103.2 \pm 13.4°$ and $88.4 \pm 12.4°$ ($p = 0.00$) for the double collar tie and double underhook, respectively). It also showed a difference in angular acceleration at the knee (5083 ± 4422 °/s2 and 1981 ± 2707 °/s2 ($p = 0.03$)) and ankle (631 ± 1371 °/s2 and 2581 ± 2191 °/s2 ($p = 0.02$)). The researchers concluded that the hip flexion angle was more acute in the double collar clinching position technique, making it preferable when striking a target lower than the striker's knee. It also revealed that the angular accelerations for the knee and ankle were similar in both positions but differed at the hip. From Trial & Wu (2013)'s study implies the importance of lower body mechanics in martial arts skills.

Further examination of the video analysis in this study revealed that some wrestlers performed the skill using their shoulder and elbow as "prime executors" of the technique, while other wrestlers utilized their hips as the point of technique execution and incorporated the shoulder and elbow joints as stabilizers

of the opponent. Put simply, during the study, the bulk of the work snapping opponents down to the mat was coming directly, rather than indirectly, from the shoulder and elbow. Wrestlers who began the motion with their hips turned their body into a whip, starting in the lower half and carrying through to their arms. With this discovery it is logical that future studies are warranted to investigate the kinematics of lower extremity motion in the snap down technique. Some limitations in this study should be considered. The sample size, six wrestlers, provided a preliminary understanding in this research study. With a greater sample size, the power of the statistical analysis will increase, which might allow us to detect any significant difference in the upper extremity. In addition, the experience level of participants had a greater than expected variation, ranging from 3 to 10 years. With a more controlled experience level, the variability of the results between subjects should be reduced. Another rather difficult variable to account for was body size. While the research study called for a weight range of approximately 50 pounds (wrestlers were between 125 and 175 pounds), participant height and body composition was an uncontrollable factor. A future study may be designed that would provide a more complete understanding of the snap down technique.

Conclusion

This study used six college wrestlers to examine the ambidexterity of the snap down technique. This study provided a basic understanding on the kinematic mechanics of the snap down technique in Folk Style wrestling when performed on the dominant and non-dominant sides of the upper body. The results showed no significant statistical difference at the shoulder or elbow joints regarding angular displacement, velocity, or acceleration when compared bilaterally. Therefore, this study concluded that collegiate level athletes are capable of executing the snap down technique with near ambidexterity in the upper extremity. Future studies are warranted to examine the lower body mechanics and with different experience levels and weight classes.

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About the Author

Nicholas DeCastro is a senior Athletic Training major. His research project was completed in the summer of 2014 under the mentorship of Dr. Tom Wu (Movement Arts, Health Promotion & Leisure Studies) and made possible through funding provided by an Adrian Tinsley Program Summer Research Grant. Nicholas was previously published in *The Undergraduate Review* during his freshman year. Upon graduation he plans to pursue a career in either the high school setting or with returning veterans in the military.

From Goal-Striving to "Right Intention": A Grounded Theory Analysis of Interviews with Mindfulness-Based Stress Reduction Participants

JULIA FIELD

Anxiety, depression, and chronic pain can be crippling ailments. Many patients turn to medications and a variety of therapies to relieve their distress. However, even "effective" treatments may not completely eradicate symptoms. Research has shown that interventions such as Mindfulness-Based Stress Reduction (MBSR) can help patients learn to live with debilitating conditions when traditional medicine cannot alleviate pain altogether. Although there is a great deal of quantitative research addressing the efficacy of Mindfulness-Based Interventions (MBIs), there is a lack of research detailing the psychological mechanisms through which these programs actually work. The current project explored how graduates of an MBSR program discussed changes in their intention to practice mindfulness before, during, and after the course.

To understand the foundations of mindfulness-based practices, this paper first describes the fundamental concepts of Buddhist Psychology. The intention is to review the modern-day, Western understanding of mindfulness: the primary mechanism of MBSR. After integrating the origins of mindfulness practices with current clinical applications, an overview of quantitative studies examining the efficacy of MBIs is provided, and the drawbacks of common mindfulness measures are discussed. While quantitative methods are relevant and important for outcome research, qualitative approaches expand the type of research questions that may be explored. Grounded Theory (GT), the qualitative framework for analyzing interview data used in this research project, is described. Finally, extant research pertaining to MBI participants' expectations and goals is addressed.

Buddhist Psychology
Mindfulness is a term derived from Buddhist traditions developed over thousands of years. As Buddhist practices

were incorporated into 20th-century Western culture (e.g., Suzuki, 1970) they were seen primarily as a religion or a set of spiritual practices. More recently, scholars have come to appreciate the psychological components of these practices, and the past three decades have seen significant incorporation of those techniques in secular approaches to health (Benson, 1983; Koerner & Linehan, 2000). However, various scholars are now highlighting that key concepts, critical to understanding how mindfulness works, were lost in translation (Grossman, 2011; Olendzki, 2010; Shapiro et al., 2006). The present paper examines one aspect of mindfulness that has been overlooked in the psychological literature: practitioners' intentions.

The Four Noble Truths and the Eightfold Path
In order to understand critical concepts often overlooked by Western psychologists, one needs to understand Buddhist psychology as it was initially taught. "The Four Noble Truths" are the Buddha's explanation of the problem of suffering; they were outlined as universal conditions of being human, while the "Eightfold Path" proposes techniques for overcoming suffering. "The Four Noble Truths" are (1) all beings suffer due to the impermanent nature of our internal and external worlds; (2) attachment is the root of suffering because we desire permanence in a world where everything changes and are attached to our wishes for how we want the world to be; (3) anyone can alleviate their personal suffering by cultivating an acceptance of things as they are; and (4) they can do so (cultivate an acceptance of things as they are) by following the Eightfold Path. The Eightfold Path is a set of guidelines for mental discipline, behavior, and social interaction that enable the practitioner to meet suffering in a new way. The guidelines are right view, right intention, right speech, right conduct, right livelihood, right effort, right thought, and right concentration (Olendzki, 2010). Of the mental disciplines outlined in the Eightfold Path, the one of interest here is right intention, or the deliberate cultivation of more developed or skillful intentions for acting or being in the world. Practitioners are taught to meditate to become more fully aware, in order to gain insight into the workings of their minds and the nature of suffering, so as to reduce or eliminate it.

Mindfulness-Based Stress Reduction
MBSR is an eight-week program designed to help both clinical and non-clinical populations to manage stress reactivity through contemplative practices such as meditation, gentle yoga, and mindful walking. Kabat-Zinn (1990) created the MSBR program in 1979; he defines mindfulness as "paying attention in a particular way; on purpose, in the present moment, and nonjudgmentally" (p. 4). Although Western psychologists reference this definition in their studies of mindfulness, few fully define mindfulness. Shapiro, Carlson,

Astin, & Freedman (2006) are a rare exception: they clarified Kabat-Zinn's definition of mindfulness by teasing apart three axioms they interpreted it to contain. By axioms, Shapiro, et al. meant specific qualities of mindfulness. In particular, their axiom "intention" captures Kabat-Zinn's phrase "on purpose." Historically, mindfulness practices were intended to cultivate compassion and enlightenment, which should be included in any model of mindfulness (Shapiro & Schwartz, 2000). In other words, Western psychologists seem often to ignore the purposes for which practitioners engage in mindfulness meditations. By ignoring meditators' intentions, researchers are missing an important aspect of the process.

Quantitative Approaches to MBSR Efficacy

There is ample evidence supporting the efficacy of Mindfulness-Based Interventions in improving both the physical and psychological well-being of participants (Brown & Ryan, 2003; Carmody & Baer, 2007; Davidson & Lutz, 2010; Salmon, Santorelli, Sephton, Kabat-Zinn, 2009). In an attempt to study MBIs in more detail, several self-report questionnaires aim to examine changes in mindfulness (Cardaciotto et al., 2008; Chadwick et al., 2008; Lau et al., 2006), usually in pre- to post-intervention designs. Grossman (2008, 2011) commented on the use of such questionnaires and suggested that the measures, while reliable, may not necessarily be valid. His main criticism is that they cannot measure "mindfulness" because Western psychologists lack a clear definition or objectively observable criterion. This makes it impossible to know what exactly is being measured. For example, some researchers treat mindfulness as a trait, similar to openness or agreeableness (Latzman & Masuda, 2013), while others treat it as an ongoing psychological state, akin to attentiveness (Langer, 1990). Neither of these fully capture the concept described in Buddhist psychology. Further, several researchers have noted a lack of studies exploring how MBSR and other MBIs work (Mamberg, Bassarear & Schubert, 2013; Salmon et al., 2009; Shapiro, Carlson, Astin, & Freedman, 2006). In order to understand the subjective experience, a clearer definition of mindfulness and the use of qualitative methods are necessary.

Qualitative Approaches to MBSR: Grounded Theory

Following Shapiro et al.'s (2006) imperative to clarify intentionality when examining MBIs, the current study explores participants' reasons to practice by analyzing in-depth interviews. Qualitative MBSR studies are becoming more common in the last ten years (Irving et al, 2012; Smith, Graham, & Senthinathan, 2007, Mackenzie et al, 2006). Grounded Theory (GT) is a systematic method of closely analyzing discourse to capture participants' meanings without imposing the researcher's agenda (Charmaz, 1995; Willig, 2008). For the purposes of this study, four discrete stages

were distilled from the GT process: (1) interviews structured to elicit participants' own narratives about their practice, (2) transcription of the digitally recorded interviews using a detailed scheme showing what participants said and how they said it, (3) Open Coding, which captures the content of what each participant said, and (4) Focused Coding, which examines the coded content in order to identify common themes within and across participant interviews. Using a process of constant comparison, codes are sub-divided, revised and integrated, creating "thematic categories." GT entails an ongoing process of revising and re-interpreting until the data yield no additional themes.

Practitioners' Expectations and Goals

People decide to practice mindfulness meditation for a variety of reasons. Doctors refer patients to MBSR programs when treatment for physical or mental ailments is not available or has been inadequate to reduce suffering. Others self-refer due to general life stress. The MBSR literature suggests that participants begin the MBSR course expecting to achieve tangible outcomes and that during the MBSR course, there is often a shift in understanding mindfulness as a way of being rather than a means to an end; their goals shift from outcome to growth and from product to lifestyle (Kabat-Zinn, 1990; 1994; Santorelli, 1999). Despite these clinical anecdotes, researchers have not deliberately explored how participants shift from goal-striving to living mindfully. However, there was a hint of this issue reported in Mackenzie et al.'s (2006) qualitative study, in which they examined nine patients in an oncology setting who had completed an MBSR program. One participant reported his motivation for taking the course: "There was no treatment left for me. I felt I'd better figure out how to cope with this disease. Meditation was what I thought I had to do." Several of the participants saw MBSR as a final chance to learn to cope; while they could not change their predicament, the program enabled them to shift their attitudes toward it. By the end of the course, participants stated that they found new ways of perceiving their present life situations; many discussed mindfulness as a lifestyle, not simply another treatment or skill. These and similar findings among health professionals (Irving, et al, 2012) served as the inspiration for a more detailed analysis of participant intentions for the present study.

The Present Study

Given the gaps in the literature outlined above, the present study examined intentionality through interviews with former MBSR participants about their subjective experience of practicing mindfulness. For the purposes of this paper, intention is defined as the practitioner's stated motivation for, or attitude toward, practicing mindfulness meditation. The goal was to explore what participants learned from taking the

course, and particularly whether their stated intentions for taking the course and for practicing mindfulness shifted once they learned MBSR. The guiding research question therefore was, "After taking the MBSR course, how do participants discuss shifts in their intention to practice mindfulness?"

Method
This study was part of a larger project in which semi-structured interviews were conducted with adult members of a small, rural, liberal-arts-college community who had taken an MBSR course with one of the principal investigators, a professor who was trained to teach the MBSR course at the Center for Mindfulness. The purpose was to learn what participants felt was most helpful during and after the course and to understand how participants incorporated MBSR into their identities. Relevant aspects of that larger study, as well as the present study's specific portion, will be described.

Participants
Volunteers were recruited from among all who had completed an MBSR course on campus in the past four years, and who had indicated at the completion of the course that they would be interested in participating in future research studies. Participants (N = 14) consisted of college students, faculty, and staff. There were five students whose ages ranged from 21 to 26 (x^- : 22.4 years). There were nine faculty and staff whose ages ranged from 47 to 61 (x^- : 53.56 years). There were six males and eight females. It should be noted that no claims are made regarding these subgroups. Demographics are provided for descriptive purposes only.

Data Collection
Interviews were conducted in an office setting and used a semi-structured interview schedule, which contained ten questions with follow-up prompts. (See Appendix A for a sample question.) Interviews lasted an average of 47.5 minutes. All participants had a prior relationship with the interviewer, which was assumed would encourage interviewees to share their subjective experiences most fully. The goal of the qualitative interviews was not to assess outcome, but to elicit the participants' interpretations of their own learning processes. The interviewer was familiar with terms and activities from the course, which were likely to come up in conversation. Lack of this familiarity could prevent an untrained interviewer from understanding subtle points. GT does not presume the interviewer should be neutral. The goal of this method is to elicit the richest, clearest data from the interviewees.

Institutional Review Board (IRB)-approved procedures were followed for maintaining confidentiality. Demographic data were stored in a Microsoft Access database and kept separate from interviews and consent forms to maintain confidentiality. Each participant was assigned a pseudonym for use in presentation. A digital voice recorder was used to create electronic audio files of the interviews. These files were then uploaded to iTunes where they could be listened to during transcription.

Transcription
The recorded interviews were transcribed in Microsoft Word using a USB-linked, foot-pedal transcription machine, which allowed frequent pausing and rewinding of the audio files in iTunes. Qualitative analyses depend on data that carefully maintains the participants' exact wording, in order to best capture their intended meaning. A detailed transcription scheme (see Appendix B for sample conventions) was used to transcribe verbatim for close analysis (Ochs, 1979). The goal was to capture not only participants' statements, but also discursive aspects of the interview conversation such as overlaps, cut-offs, laughter and other meta-linguistic features, which aid analysis and interpretation. This process ensured the researcher's pre-existing assumptions were less likely to interfere with coding participants' statements. Once transcribed, all 14 interviews were reviewed for accuracy by a second transcriptionist. Each completed transcript was converted to an .rtf file and uploaded into Atlas.ti, a qualitative database used for coding.

Data Reduction
GT turn-by-turn coding was used to analyze each transcript. That is, the unit of analysis was a speaker's conversational turn, primarily those of the interviewee. Since many of the interviewer's turns were simply statements displaying active listening ("Okay," "Mmmhmm," etc.), the interviewer's turns were rarely coded. Rather, they were used to mark each formal interview question (highlighting the structure of each interview), as well as follow-up prompts and introductions of new concepts. Data analysis was broken into two processes: open coding followed by focused coding (Charmaz, 1995).

Open Coding
The initial open coding process entailed a close reading of each transcript, followed by systematic recording of the primary content of each conversational turn. The goal was to fully capture the various meanings contained in each statement. Participants' turns contained multiple concepts, as expected, each of which was coded with a key word or phrase. The most important information was thus noted in a quick but thorough manner to facilitate theme generation within and across the interviews.

Three independent researchers conducted open coding independently on a subset of the data. Coders were kept blind

to each other's work using separate databases in Atlas. The principle investigator began coding to create a preliminary code list. Then each coder referred to this master codes list, adding to it as new concepts were encountered in the data. Upon completion, the coded interviews were then compared among the researchers. Any discrepancies were discussed and clarified until coders agreed on the most appropriate codes for a given turn. Generally, discrepancies were minor and consisted of terminology differences (e.g., "obstacles" vs. "hindrances," or "option" vs. "choice."). As coders reached consensus, Atlas enabled quick re-coding and refinement in the master database. Focused Coding. The second process, focused coding, entailed reviewing the master codes list, identifying codes that related to the research question, and then grouping related data into coherent themes. The research question guided the selection of codes that referred to participants' intentions for taking the course. The codes "intent" and "intention" best captured statements by participants indicating their (initial or current) approaches to practice. Fifty-two conversational turns were coded with "intent" and seven turns were coded with "intention," for a total of fifty-nine relevant turns. These turns were then grouped into coherent themes, as presented below, to address the research question. While the themes generated were mutually exclusive, some turns contributed to more than one sub-theme since they conveyed multiple aspects of the theme into which they were placed.

Analyses

Three thematic categories emerged in the focused coding process, based on the 59 conversational turns that had been coded as "intent" or "intention" in the open coding process. Seventeen turns (drawn from ten participants) contained statements indicating participants had goal-oriented mindfulness practices. This first theme was labeled, "Doing: Practicing to Achieve." Fifteen turns (drawn from six participants) contained statements indicating participants were deliberately living in a more mindful way. This second theme was labeled "Being: Practicing to Become Mindful." Fourteen turns (drawn from nine participants) contained statements indicating meta-awareness of participants' own shifting intentions: from practicing in order to achieve a goal, on the one hand, to choosing to be more mindful in their life, on the other. This third theme was labeled, "Shifting Awareness: From Doing to Being." Sub-themes were then identified within each theme.

Doing: Practicing to Achieve

The first theme, "Doing: Practicing to Achieve," reflects 17 turns in which participants stated that they were meditating for specific purposes, such as attaining a particular result or benefit. In MBSR this is called goal-striving. Some stated

that they wanted to escape from stressors such as medical conditions or taxing work schedules. Four sub-themes were identified in this category: Obtain Benefits, Escape Distress, Learn the Right Way, Attain Goal(s), as detailed below.

Obtain Benefits.

The first sub-theme, Obtain Benefits, reflects 11 turns in which participants' stated that they expected to gain something from taking the MBSR course, based on pre-conceived notions about meditation and personal experiences of self-improvement. The clearest example of this subtheme is when Keith was asked about why he enrolled in MBSR. Keith said, "…there's no pressure um you know it's just completely for ME you know I can show up and um learn something that's really beneficial." This exemplar conveys the essence of most of the turns that fell into this sub-theme: a general sense that practicing mindfulness would be educational or otherwise psychologically helpful.

Escape Distress

The second sub-theme, Escape Distress, reflects six turns in which participants indicated they meditated to escape stressors such as demanding jobs or general life events. The clearest example of this subtheme is when Ann said, "I felt I had too MUCH going on at work (4) and I thought I needed to learn how to manage (.) more without having (.) stress (h, h)." This exemplar conveys the essence of most turns that fell into this sub-theme: an intention to practice in an effort to avoid some negative aspect of reality.

Learn the Right Way

The third sub-theme, Learn the Right Way, reflects six turns in which participants conveyed that they were concerned about practicing meditation incorrectly or that there was a specific way of practicing that they struggled to attain. The clearest example of this subtheme is when Linda said, "I had bought a couple of books on meditation (.) I had bought a couple of CD's on meditation--but I didn't feel like I was probably doing IT the right way or getting out of it what I really wanted out of it." This exemplar conveys the essence of most turns that fell into this sub-theme: participants took this course with the intention of learning to practice mindfulness "correctly," which, while understandable, indicates a type of striving.

Attain Goal(s)

The fourth sub-theme, Attain Goal(s), reflects five turns in which participants stated that they practiced mindfulness in order to attain goals such as reducing blood pressure, controlling racing thoughts, and learning to achieve a tranquil state. The clearest example of this subtheme is when Clare was talking about her high blood pressure; she said, "…and

stress makes it worse so so it's like I've got to find a way to reduce my stress … and I said okay you know I need to find something that I can use that'll that'll help … cause I I can feel my blood pressure when it goes up." Clare's motive to practice was symptom reduction. This exemplar conveys the essence of most turns that fell into this sub-theme: choosing to practice in an effort to achieve a new state or accomplish some objective.

Being: Practicing to Become Mindful

The second theme, "Being: Practicing to Become Mindful," reflects 15 turns in which participants talked about being mindful in their daily lives. The data in this theme captured a different intention to practice mindfulness meditation: one that was more about a way of being than what the participants would get from practicing. Three sub-themes were identified when these data were examined: Establishing a Daily Practice, Cultivating Compassion, and Developing Curiosity. These subthemes refer to ongoing lifestyles or ways of perceiving and relating to the world.

Establishing a Daily Practice. The first sub-theme, Establishing a Daily Practice, reflects 10 turns in which participants conveyed a commitment to practice and the establishment of a daily practice. The clearest example of this subtheme is when Josslyn said,

> … Uh very careful about that first message I play in the morning (.) when I wake up (.) It's not <vc> OH NO I have to get UP I have to go <vc> -- It's <vc> (.) Okay? time to get up? Gonna get to swim now. <vc> … So it's it just completely changes everything (.) it makes- it makes [it] very easy to bound out of bed and get and get to the pool if you – if you think of it as a negative (2) Oh man! It makes it tougher?

This exemplar captures a unique daily practice that Josslyn uses to cultivate mindfulness. Additionally, Josslyn reflected on the positive impact of waking up with a mindful intention versus that of a negative, resentful awakening. This exemplar conveys the essence of most turns that fell into this sub-theme: a conscious integration of mindfulness practice into daily life.

Cultivating Compassion. The second sub-theme, Cultivating Compassion, reflects three turns in which participants conveyed an attempt to cultivate compassion or acceptance toward oneself where they previously had been judging. The clearest example of this subtheme is when Ann described her habitual reaction to making mistakes; she said, "I needn't be so harsh on myself when it seems to be part of the human condition y'know? It's NOT an affliction so to speak but it's part of being human –h so (2) I think I think that really helped…" Ann's intention here is to generate self-compassion instead of

being self-critical. This exemplar conveys the essence of most turns that fell into this sub-theme: choosing to be more self-compassionate.

Developing Curiosity

The third sub-theme, Developing Curiosity, reflects two turns in which participants reported having a novel sense of curiosity in everyday activities. The clearest example of this subtheme is when Bonnie said,

> … even when I'm running now I'm (.) I'm curious of how like (.) like my body is moving and like how,-h, different muscles ARE (.) like affecting my running ,-h, and like I realize I like (.) curl my toes:: when I run (h) never noticed that before! (h) …yeah! Just (.) yeah general curiosity of (h) I'm a very (.) MUCH more curious now! (h)

This exemplar conveys the essence of most turns that fell into this sub-theme: consciously exploring and inquiring into personal experience.

Shifting Awareness: Doing to Being

The third theme, "Shifting Awareness: Doing to Being," reflects 14 turns in which participants described their meta-awareness of transitioning from initially striving toward goals to a deeper commitment to being mindful in life. While this theme relates to the first two, it takes a wider view of intentionality because participants are directly describing their own shifting intentions to practice mindfulness. Within this theme, they talked about practicing for the sake of being mindful. They also explicitly juxtaposed cultivating ongoing mindfulness with some earlier goal-striving intention. Several of these turns referred to no longer engaging in practice solely in order to achieve something. Three sub-themes emerged in this thematic category: Noticing Choices, Noticing Change, and Redefining Mindfulness.

Awareness of Choice

The first sub-theme, Awareness of Choice, reflects seven turns in which participants recognized they had a choice in how they could respond to stressors such as difficult work situations, forgetting to do something, or negative interpersonal encounters. The clearest example of this subtheme is Bella's turn, in which she discussed her inconsistent meditation practice: "…and then being mad at myself at night for not [meditating] (4) and that I could (5) that I could just go a little deeper into that and say <vc> oh what— what's stopping you? What's the BARRIer to actually doing this? <vc> (9) it sort of reminds me that I COULD be compassionate toward myself... I could aim at myself what I aim at other people." This exemplar conveys the essence of most turns that fell

into this sub-theme: an awareness of the option to be more mindful in response to a situation they might habitually judge.

Awareness of Change

The second sub-theme, Awareness of Change, reflects four turns in which participants reported a change in perspective on a particular matter, such as changes in awareness or behaviors toward the self by being more self-compassionate as opposed to "beating myself up" or changing from being competitive with others to becoming a "better person." The clearest example of this subtheme is when Patty said,

> I think striving before was a closed kind of competitive, if you will, striving um (.) so probably against other people or against other things and now the striving is within me and it's a better … it it's an idea of BOY (.) I could really learn from pursuing meditation and um in a more intentional way so the striving is is far more personal than competitive and I don't even think -- it doesn't even feel as if I'm being compet— it's competitive part of me it's just knowing that there's more (.) knowing that I want to get there and and uh knowing that I'm open to to trying that.

This exemplar conveys the essence of most turns that fell into this sub-theme: an awareness of a change in the speaker's own attitude or behavior, usually toward a more mindful way of being.

Redefining Mindfulness

The third sub-theme, Redefining Mindfulness, reflects three turns. In this sub-theme, participants described meta-awareness of revising their underlying definition of mindfulness (or meditation) since first enrolling in the course. The clearest example of this subtheme is when Kim said,

> …I thought meditation was um (2) just about clearing your mind completely… um and that was one of the pleasant surprises about the course was that defining mindfulness and and (.) really that it's it's bringing an awareness and that's just much more practical and I don't know it it made me feel like this this— what I'm doing matters [as] opposed to trying to to to clear your mind completely and like being-- I don't know (.) being nothing y'know being-- or or as if like there are NO problems or something …

This exemplar conveys the essence of most turns that fell into this sub-theme: participants' revision of their definition of mindfulness meditation during or after the MBSR course.

Discussion

The primary goal of this portion of the larger study was to explore participants' discussion of shifts in their intention to practice mindfulness. Shapiro et al.'s (2006) model of mindfulness included intention as one of the mechanisms, yet no research studies could be found which examined participants' reports of the intentions they bring to MBSR practices. Exploring 14 semi-structured interviews conducted with individuals who had previously completed an MBSR course, revealed 993 total conversational turns. Of those turns, 59 contained participant discourse relating to their intentions to engage in mindfulness practice. The analyses presented are a first systematic attempt to develop a theory about intentionality, rather than rely on MBSR teacher's anecdotal reports.

Participants made sense of their own intentions to practice mindfulness in three ways. Some turns revealed that participants had practiced meditation as another form of goal-striving, to achieve or gain some positive outcome ("Doing: Practicing to Achieve"), while other practitioners described mindfulness practice as a means of transforming their way of being, moment to moment ("Being: Practicing to Become Mindful"). Still other participant statements noted a shift from a Doing intention to a Being intention over time ("Shifting Awareness: From Doing to Being"). Within each of these themes, various subthemes emerged across several participants, fleshing out variation within a given theme.

Of particular interest to mindfulness researchers is the way these three themes relate to the MBSR teachings about goal-striving, reducing reactivity, and enhancing compassion toward oneself and others. While those topics are sometimes discussed directly in class, more often they are only implied in the ways mindfulness practices are taught. Yet the themes of Being and Shifting show how participants have incorporated the essence of mindfulness practice into their lives, and into the ways they speak about their experience.

As described earlier, the 14 participants in this study were selected from a pool of volunteers who had completed the MBSR course at a small, liberal-arts college. Except for one participant who identified as a Buddhist, most participants did not have previous knowledge of mindfulness or meditation practices. When asked why they initially chose to take the course, participants sometimes did not have specific reasons other than the idea that the course was supposed to somehow be helpful to them. In the theme, "Doing: Practicing to Achieve," participants' reported practicing in an effort to achieve a goal or escape a negative aspect of reality. Derived as it is from Buddhist psychology, MBSR seeks to reduce goal-striving since it is ultimately a form of attachment.

Goal-striving simply maintains the cycle of suffering because participants aim at some outcome in the future or judge their practice negatively; such an intention is not in line with mindfulness as defined in Buddhist psychology. Clearly, participants are primed in our culture to bring a goal-striving attitude toward MBSR, and it is important to encourage shifts away from that intention. In contrast, non-striving embodies the original intent of mindfulness teachings, as Shapiro, et al. (2006) described. Future models of mindfulness should include intentionality as a concept integral to understanding mindfulness practice and its effects. Therefore, quantitative research studies should include non-striving intentions within their operational definitions.

In addition to the analyses discussed, this project also displayed the usefulness of qualitative methods in the study of mindfulness. The GT approach to participants' reports about their intentions to practice mindfulness allowed a highly detailed examination of the 14 in-depth interviews. The subjective experience of practitioners' intentionality is clearly a complex concept. Intentionality has been neglected in mindfulness research, but these analyses show it is an important mechanism in developing mindfulness practice after the course ends. The results of this study suggest the need for more qualitative research using the tools of Grounded Theory to understand the subjective processes of practicing mindfulness.

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About the Author

Julia Field graduated in Spring, 2014 with a B.S. with honors in Psychology. Her year-long research project was completed in the spring of 2014 under the mentorship of Dr. Michelle H. Mamberg (Psychology) and made possible with funding provided by several Adrian Tinsley Program research grants. Ms. Field presented this project at the New England Psychology Association (NEPA), in Lewiston, ME in October, 2014. She plans to apply to doctoral psychology programs in the fall of 2016.

Closer Than You Think: The Influence of Border Bias on Perceptions of Mapped Hazards

Sarah Gardiner

On January 9, 2014, almost 300,000 West Virginia residents were left without water for up to a week after 10,000 gallons of chemicals used in coal processing leaked into Charleston's water supply. Little is known about the health effects of the chemicals, but residents were advised to avoid exposure and many complained of feeling ill. Long after Jeffery L. McIntyre, president of West Virginia American Water, assured residents that the levels of 4-methylcyclohexane methanol (MCMH) in the water supply was found to be less than the United States Centers for Disease Control and Prevention (USCDC) designated "protective of public health" level, local residents continued to complain about the foul smell. Despite his reassurances, McIntyre also conceded that pregnant women should consider an alternative drinking water source until the chemical was at a "non-detectable" level throughout the distribution system (McIntyre, 2014).

While the long term environmental effects of such disasters are unknown, there are some predictable outcomes. People will fear that their natural resources (the water supply, food supply, animal habitat) have been contaminated such that their health and wellbeing are endangered. As evidence of this, at one Charleston, WV town meeting just 1% of the 200 attendees reported that they had begun drinking the water again after four days. In contrast, the Boston Globe included just 17 stories about the WV chemical spill and coverage waned in weeks. Globe reporters never mentioned similar hazards in the metro area. There are certainly similar chemical tanks and hazards nearby, and similar events and outcomes may indeed impact the Boston area. Shouldn't other vulnerable areas across the country learn from the events in West Virginia? Globe reporters either did not see the connections between the West Virginia incident and local exposure or assumed that readers would not be interested. One explanation may be cognitive construals, which are how individuals perceive, comprehend, and interpret the world around them in relation to emotional, physical or temporal distance. Past research suggests that spatial distance (feeling closer to or farther from things) changes how people perceive, represent,

and act on objects and ideas (Trope & Liberman, 2010). For example, construal theory suggests that people think about distant events more abstractly by attending to features that are central to meaning and goal relevance. Proximal events tend to be described concretely with more detail, contextual information, and incidental features (Liberman & Trope, 1998). This bias persists even when there is concrete, reliable information available (Henderson et al., 2010) and research suggests that spatial nearness, real or imagined, may result in very different levels of interest, attention to detail, and personal involvement. For instance, Fujita and Henderson (2006) asked participants to imagine helping a friend with a nearby move (within three miles), or a distant one (three thousand miles away). When considering a list of related behaviors, such as locking a door, participants who imagined helping with the nearby move tended to describe the effort concretely in terms of its means ("putting a key in the lock"), whereas those who imagined helping their friend move a great distance tended to give a more abstract description in terms of its ends ("securing the house"). Herbert (2010) called this tendency to think of distant events more abstractly than proximal events the "mapmaker heuristic." In another example, researchers primed participants with spatial closeness or distance using a Cartesian-plane coordinate system. After the manipulation, each participant read an embarrassing book excerpt and rated how much they liked it. Participants who had plotted points closely together on a graph reported more discomfort after reading the embarrassing story than those who graphed distant points. The authors concluded that the act of plotting close points primed participants to think about crowding or nearness of others, while participants who were given a sense of psychological distance felt less of the emotional discomfort (Williams & Bargh, 2008).

Another factor implicated in cognitive distancing is the existence of borders. Mishra and Mishra (2010) coined the phrase "border bias" after participants considered an earthquake within the same state to be of greater risk than an equidistant one that occurred in a different state. The authors concluded that boundaries, such as state borders, may be cognitively processed as protective physical barriers rather than abstractions. In other words, people may use state borders to maintain an illusion of safety from disasters. To further examine border bias in this context, Mishra and Mishra (2010) used dark or light state borders on a map that depicted an environmental risk. As hypothesized, the dark borders enhanced border bias and the light borders reduced the effect. Border bias is reflected in past research regarding environmental concerns such as global warming. For example, Americans tend to report that climate change will affect geographically and temporally more distant places (Leisorwitz, 2005) and

express little concern about any immediate dangers from global warming (Kellstedt, Zahran, & Vedlitz, 2008). In New Zealand, Milfont, et al. (2011) found that participants rated the quality of local ('My Area') and national ('New Zealand') environmental conditions more favorably than global environmental conditions and reported that, "things are better now than they will be in the future." In a related study Gifford (2011) found that participants were more engaged in climate change issues if they had previously read an excerpt about the effects of local rather than global climate change. Molloy et al. (2012; 2013) found similar local, regional and national biases in a series of studies on perceptions of pollution, environmental behaviors and global warming related natural disasters. Further indication that graphical representations alter risk perception comes from research focused specifically on map reading. According to Lahr and Kooistra (2009), maps are the best way to convey information about locations and depict disasters. The authors stress, however, that maps of hazards should only be created by someone with sufficient knowledge of cartography, environmental threat assessment, and risk communication, because poorly prepared maps can be misinterpreted and risks misjudged. For example, Arlikatti et al. (2006) found that only 36% of residents could correctly identify areas of hazardous risk in which their own homes were located, on maps that utilized small scales or few feature markers. Maps with insufficient structural (spatial representation) and feature detail (size, form, and color) appeared to impair participants' ability to process the map and make meaningful judgments about their own neighborhood (Johnson et al., 1995).

Table 1
Pilot Study Chi-Square Results for Home Choice

Condition	Expected		Actual	
	In	Out	In	Out
Fracking Site				
MA (n=50)	23.7	26.3	19*	31*
NH (n=52)	27.4	24.6	27	25
Control (no fracking)				
MA (n=73)	34.6	38.4	42*	31*
NH (n=51)	26.9	24.1	30	21

*Results significantly different from chance, p < .05

In Severtson and Burt's (2012) examination of mapped hazard risk assessment, the authors varied structural characteristics, by altering cluster shape and size to influence perceived density and proximity to hazards, and feature characteristics,

by changing the color of dots depicted on maps of well-water test results for a fictitious contaminant.

Table 2
Current Study Chi-Square Results for Home Choice

Contaminant Cause	Actual	Expected
Fracking Site*		
Color Border	57	81
Double border	57	33
Total	114	114
Train Derailment*		
Color border	57	16
No border	57	98
Total	114	114
Chemical Spill*		
Closer to border	58	71
Farther from border	58	44
Total	116	116

* Results significantly different from chance, p < .05

While structural features did appear to influence risk beliefs, the feature manipulation, specifically the use of the color red, was more influential than cluster shape or size. Severston and Vatovec (2012) also found a strong effect for color. They had participants view three formats of water test results from a private well: a choropleth map (with shading, coloring, and symbols to show values), a dot map, and a table. The results of cognitive interviews that assessed what was seen on the maps and tables, perceived meaning, and prior knowledge about maps/tables, suggested that participants derived symbolic meanings of risk based on color: red meant warning, yellow meant caution, and blue/green meant safe. Griffith and Leonard (1996) found similar results in a study of the vocabulary of warning signals. Participants were given a signal word (out of 40 possible words) and were asked to respond with the first color that came to mind. The word 'danger' elicited the response "red," the word 'caution' prompted the response "yellow," 'warning' produced the response "orange," and 'fatal' or 'poisonous' invoked the response "black." Overall the color red was the most common response to all signal words and
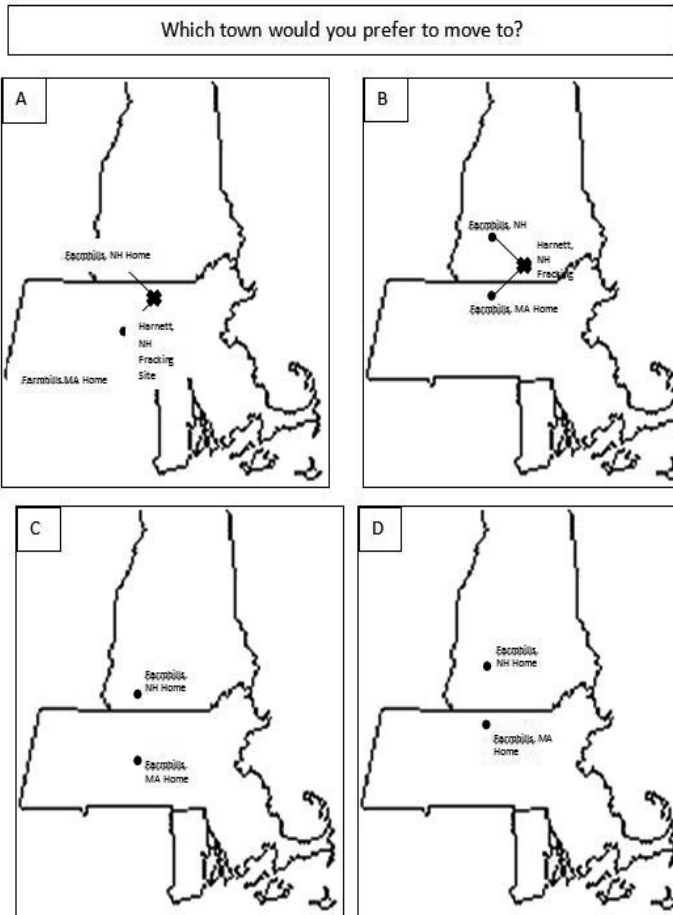
Figure 1: Pilot Study Map Choice. After reading a scenario about having to move to a new location for school or work, participants viewed one of the four maps. In the experimental conditions, participants chose between two home locations equidistant to a hydraulic fracking site; the control conditions did not contain a fracking site.

environment than those in more distant communities. While their responses seem counterintuitive, much research on risk aversion suggests that exposure to unavoidable risk may skew our perceptions of hazards and change how we deal with them (Paulsen et. al, 2012). Those who already live near hazards may deal with their exposure to risk with denial, creating explanations to minimize vulnerability, and focusing on the best possible outcome—that they will escape any ill effects of living near a chemical plant.
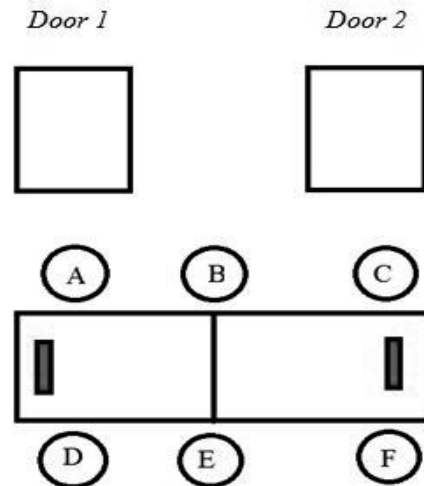
Figure 2: Current Study Lab Seating Choice. Behavior was recorded when participants arrived in the lab to find contaminants at each end of their table. Participants were offered 6 seating options on either side of two connected tables: 4 directly next to a contaminant and 2 on the "double border" (location where the two tables met).

more signal words were evoked by the color red than by any other color. The authors believed the results reflect the way the color red is encountered in everyday life, such as on stop signs and red lights that indicate risk.

While the research described above indicates that nearness and maps with clear structure and feature information prompt more local and concrete thoughts regarding risks, Heath et al. (1998) found contradictory evidence. The authors surveyed two communities in the Houston area, each of which was divided into three subsamples based on their zip codes. The level of risk to subsamples was categorized as high (within 5 miles) and low (more than 20 miles) based on distance from local chemical plants. Participants were asked questions about their proximity to the chemical plants and opinions about their health and safety. The authors found that people in communities closer to chemical plants reported less concern about their health and safety and more confidence in efforts to protect the

Most research on risk aversion focuses on a gambling paradigm, not mapped hazards. A long history of research indicates that, although people tend to prefer a small gain over a gamble for more, when faced with outcomes framed as losses, people often express a preference to gamble, even when the mathematical probability of the gamble is inferior (Kahnenman & Tversky, 1984; Paulsen et. al, 2012). More relevant to the current research and Heath et al.'s (1998) findings, such behavior has been observed in medical decision making. For example, Eraker and Sox (1981) found when the outcomes were adverse drug effects (a loss), participants were willing to risk experiencing severe side effects in order to have a chance of experiencing no adverse reaction. Also relevant to the current studies, a substantial body of evidence supports ambiguity aversion, also known as the Ellsberg paradox (Ellsberg, 1961). Most decision makers prefer risky prospects with equal outcome probabilities over ambiguous options (Camerer & Weber, 1992; Frisch & Baron, 1988; Rode,

Which location would you prefer to move to?
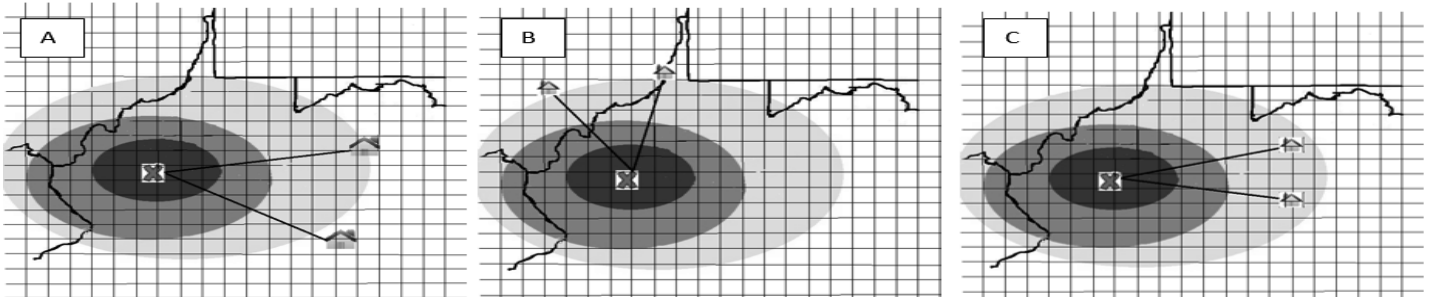
Figure 3: Current Study Map Choice. Participants read a scenario for each of the three water contaminations: hydraulic fracturing, train derailment, and a chemical spill. They then viewed each of the three maps below, which provided them with two choices for home selection equidistant to the water contamination.

Cosmides, Hell, & Tooby, 1999). Pulford and Colman (2008) recently found that ambiguity aversion was strong even when the need for mental calculation was eliminated, leading them to conclude that ambiguity may prompt aversive psychological state generated by exposure to uncertainty. In sum, humans appear to be naturally risk averse and demonstrate preference for certainty, but may gamble with money or their health when faced with outcomes framed as losses.

Taken together, these results suggest that, in evaluating hazards and risks, individuals may understand events and represent activities more concretely in the aftermath of a nearby disaster, but more abstractly and globally when temporal and spatial distance is increased. Cognitive distancing is a heuristic that not only influences perceptions of actual distance in inches and miles, it also affects our perceptions of emotional distance, and our sensitivity to threat. Because our brains have formed a deep-wired connection between distance and safety, the mapmaker heuristic may influence evaluations of and judgments about risk (Herbert, 2010). In addition, research indicates that the way in which disasters or hazards are displayed on colored maps, with nearby or more distant borders, could impact perceptions of risk and decision making under uncertainty.

Previous research on border bias utilized black and white maps (see Figure 1) and focused on natural disasters (Mishra & Mishra, 2010; Molloy et al., 2012; 2013), not chemical hazards. Therefore, a pilot study was conducted to establish that borders would be relevant in judgments about contaminated groundwater. Materials included black and white, single border maps depicting a hydraulic fracturing site where groundwater could be contaminated, and equidistant food sources or home alternatives, either within or outside of state borders. Stimuli were similar to those used by Molloy and appear in Figure 1. Results replicated previous research in that the vacation home choice reflected border bias. As expected, control condition participants preferred the in state equidistant homes, and when the fracking site was in Massachusetts, they preferred a New Hampshire vacation home. However, a fracking site in New Hampshire appeared less likely to inspire border bias (see Table 1 for details).

After substantiating that groundwater contamination risk assessment could be influenced by a border bias manipulation, the current study was designed to reflect our main interest: the effect of color and boundary ambiguity on the risk assessment of mapped hazards. It was once again hypothesized that evidence of border bias will be found in participants' choices of where they might like to live, shop, or attend school, their ratings on various explicit questions about risk, and their legal attributions. Based on past research on the effects of color, we expected that color borders would prompt a bias similar to state boundaries. Based on research on risk and ambiguity aversion, it was also hypothesized that participants would feel vulnerable on a "double border" (being in two places at once). The current study was designed to test this hypothesis in two ways. First, maps in one condition included a double border in the form of a state border and a color border (See Figure 3, labeled Current Study map choice), which participants were expected to avoid in preference for an equidistant option on just one border. Second, behavior was recorded when participants arrived in the lab to find contaminants at their table (see method section for more details).

It was hypothesized that seating choice would reflect ambiguity aversion in that participants would be more likely to risk sitting in a seat next to one contaminant in order to avoid the ambiguous vulnerability of exposure to two contaminants.

Method

Participants

The sample, 38 male and 73 females from Bridgewater State University, ranged in age from 18 to 34 (M = 19.35), having six participants who chose not to reveal their age. Participants received research participation credit in a psychology course.

Materials

Survey packets included summaries of equivocal legal case vignettes and colored maps depicting potential water contaminants, equidistant food sources or home alternatives (see Figure 3). Participants reviewed three vignettes and maps, one for each event (train derailment, chemical spill, or oil fracturing wastewater leak), that precipitated potentially contaminated ground water. The train derailment, the chemical spill, and the oil fracturing vignettes were brief summaries of current, equivocal legal cases resulting from disasters that impacted the environment and can be seen as hazardous. As for the maps, distance from the event remained the same across conditions; only the proximity of borders was experimentally manipulated. All three maps were devised to measure the effects of border bias. Map B was designed to measure the effect of a "double border." Participants were asked to determine where they might like to live, shop, attend school, etc., and indicated their perception of risk on a Likert scale (A 4 item measure of severity specific to the environmental impact of each potential hazard). Demographic questions and several individual difference scales were used including: the Need for Cognition scale (Cacioppo & Petty, 1982), and three measures of environmental concern: the New Ecological Paradigm scale (NEP; Dunlap, Van Liere, Mertig & Jones, 2000), the Behavior-based Environmental Attitude scale (BBEA: Kaiser & Wilson, 2004), and Personal Efficacy Global Warming (PEGW: Kellstedt, Zahran,& Vedlitz,. 2008).

Procedure

Participants (up to six at a time) arrived at the psychology lab to find a "contaminant" (rumpled tissues) on the both ends of a work surface comprised of two tables pushed together. The participants were asked by the researcher to find a seat at the table. Participants were offered 6 seating options on either side of two connected tables: 4 directly next to a contaminant and 2 on the "double border" (location where the two tables met). The seating arrangement was used to measure risk aversion; seats next to the contaminant would be considered certain risks, while those on the "double border" were ambiguous options because they were equally distant to each of the contaminants (causing the participant to be at risk for exposure to both; see Figure 2 for a schematic). Once all the participants were seated the researcher acknowledged the contaminant, apologized for the mess, and cleaned the table. The seat chosen by each participant and the order in which they sat served as an implicit measure of ambiguity aversion. Participants were then asked to begin the pencil and paper survey. After each participant finished and returned their survey, the researcher handed them a debriefing slip.

Results

As hypothesized evidence for border bias was found for all three cases and maps. In the train derailment case, participants preferred the equidistant home beyond the color border (X2(1) = 58.98, p =.00; Figure 3, Map A). In the fracking scenario, participants were significantly less likely to choose a home on a "double border" indicated by both color and state lines (X2(1) = 20.21, p = .00; Figure 3, Map B). Finally, in the chemical spill case there was a significant difference in home selection when neither of the homes were located on an identifiable border (X2(1) = 6.34, p = .01; Figure 3, Map C). This finding was not predicted, but does support border bias because even though the two locations were within one state, participants preferred the location that was closer to the state border over the location that was further from the state border.

Chi-Square results supported the hypothesis that participants would demonstrate ambiguity aversion when choosing a seat in the lab. They preferred available seating choices located near the contaminants over the seating choices located on the "double border" (X2(1) = 7.35, p = .007; see Figure 2).

Participant's responses to the 4 item measure of severity specific to the environmental impact of each potential hazard was significantly correlated with scores on the measures of environmental concern (rNEP (114) = .264, p < .01; rBBEA (110) = .280, p < .01; and rPEGW (109) = .289, p < .01; and with Need for Cognition (r (97) = .220, p < .05).

Since each participant reviewed all three water contamination events, a Within Subjects ANOVA test was used to measure whether environmental impact assessment differed in the fracking, chemical spill and train derailment disasters. Each participants rated the environmental impact (environmental severity: property values, health risks, and other features of the homes and surrounding areas) as less severe in the train derailment event than the fracking and chemical spill disasters (F (2,114) = 34.36, p = .00, η2 = .38), however there was no indication that preferences regarding homes, schools or shopping were influenced by environmental impact.

Discussion

The purpose of the current study was to demonstrate that mapped state and color borders may be perceived as protective barriers in groundwater contamination. Results from the current

study replicated previous research that state borders may be perceived as protective barriers, and extended the findings to color edges, which may also be cognitively processed as borders and perceived as protective. Results also showed support for the hypothesis that participants would be less likely to choose a home on a "double border" and would rather sit closer to one contaminant than be in the more ambiguous position of sitting further away, and equidistant from, two contaminants. This may indicate a perceived vulnerability of being in two potentially hazardous locations at once. The finding supported research in the areas of risk aversion because participants appeared to gamble in the face of a sure loss (exposure to contamination). Similar to Eraker and Sox's (1981) patients, participants in this study appeared willing to risk experiencing more severe health outcomes (illness due to closer contact with one set of germs), in order to have a chance of experiencing no ill effects (possible immunity). The results also support research on ambiguity aversion because participants choose certain exposure to one contaminant over ambiguous exposure to two. Perhaps by sitting nearer to one contaminant the participants felt sure of their level of exposure, but perceived the "double border" as an uncertain level of risk.

The finding that the fracking and the chemical spill cases were perceived as having more environmental impact than the train derailment case was not predicted. Since all of the legal cases described disasters that led to potential groundwater contaminants, and cases were counterbalanced, there was no reason to expect significant differences between cases. One possibility is that participants were influenced by recent media coverage on the dangers of chemical spills and fracking. The New England area, from which the student population was drawn, was expected to experience increased prices for natural gas, which had prompted a temporary uptick in media coverage of hydraulic fracturing. In addition, while New England area coverage of the West Virginia disaster was minimal in comparison with the area more proximal to the event, it was a more recent and nearby event than the train derailment in Canada. It is also possible that the ratings for environmental impact severity are another reflection of border bias. A train derailment that spilled chemicals into the groundwater in Sudbury, Ontario, Canada may have been perceived as less severe because it occurred over a national border. This would be in alignment with Molloy (2013) who found national biases in a series of studies on perceptions of pollution, environmental behaviors and global warming related natural disasters.
The current studies contributed to the body of research on how border bias and colors may influence risk assessment of mapped hazards that involve pollution and contamination and suggests the need for further research on map how map reading skills and education may enrich short and long term

decision-making, including risk assessment. The information gathered from current and future research could change how the media, insurance agencies, environmental agencies, governments, etc., communicate risk to the public. Lahr and Kooistra (2009) argued that maps are the best way to convey information about locations and disasters and, the current findings regarding map features indicate that color, structure, and borders can be successfully manipulated to change how one views a hazard. Color could be used to depict what areas will be most affected by the hazard. Structure could be altered to display the hazardous location in relation to the rest of the world. The effects of border bias might be reduced by making borders appear less noticeable to decrease the false sense of security that seems to be primed by boundaries. The preparation of maps should be left to experienced map makers, who could and should use these manipulations as a tool to communicate risk. Proper map design could lead to better awareness of local and global environmental issues, fewer miscommunications regarding the risks of exposure to hazards, and fewer casualties in times of crisis.

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About the Author

Sarah Gardiner is a graduating senior majoring in Psychology and minoring in Special Education. Her research project was conducted in the summer of 2014 under the mentorship of Dr. Elizabeth Spievak (Psychology) and made possible with the funding provided by an Adrian Tinsley Program summer research grant. She plans to pursue her Master's of Special Education in the fall of 2015.

Dynamics of Climate Change: Explaining Glacier Retreat Mathematically

ROBERT GUILLETTE

Introduction
Glacier Retreat

Glaciers currently cover 10% of the Earth's land, blanketing more than 15 million square kilometers of the planet. However, as the world's climate continues to undergo monumental shifts, these mobile masses of ice are being dramatically affected. Glaciers across the globe have been increasingly losing mass over the last century. From 2003 to 2009, glaciers worldwide lost between 231 and 287 trillion kg of ice per year (Kerr, 2013). Carrara & McGimsey (1981) reported that by 1980 Glacier National Park in Montana had lost over two-thirds of the 150 glaciers it was estimated to have in 1850, while the remaining glaciers have suffered a significant reduction in area. The Muir glacier, situated in Glacier Bay National Park, Alaska, also underwent a dramatic retreat between the years 1941 and 2004, as can be observed in Figure 1. The photos visually compare the Muir glacier in 1941 to its state in 2004. Field and Molnia (n.d.) report that the glacier retreated more than 12 km and thinned by more than 800 meters in that 63-year time frame.

Figure 1: Evolution of Muir glacier.

Glaciers are extremely sensitive to changes in climate, and many studies link temperature, precipitation, and insolation to glacier retreat (March & O'Neel, 2011; Peduzzi, Herold, & Silverio, 2010; Robson, 2012). The sensitivity that glaciers exhibit toward climatic factors make these mobile ice masses "excellent barometers of climate change" (Hall & Fagre, 2003). Therefore, studying the relationship between the retreat of glaciers and changes in climate is of utmost importance, as glacier retreat signals a shifting climate.

Description of Research Question

As the earth's climate is currently undergoing significant changes, glaciers around the world are retreating at a staggering pace. The rapid melting of glacial ice will have serious consequences that impact people and animals on a global scale. In order to mitigate the severity of these consequences, we must first better understand the relationship between climate change and glacier retreat. In this article, we construct a mathematical model of glacier retreat representing how changes in climatic factors, such as temperature and precipitation, affect the ice mass of a glacier. We perform a multiple linear regression using data for the Midtfonna glacier in Norway to study the effects of temperature, precipitation, local climatic phenomena, wind speed, and insolation on the glacier's total area. Our goal is to determine what proportion of the total variation in the glacier's ice mass over the past decades can be explained by the five climatic factors.

Our second objective is to create a method for predicting the evolution of a glacier over time by using different climate scenarios projecting future temperature and precipitation. Given that one-sixth of the world's population depends on glacier ice and snow melt for its water supply, a mathematical model predicting the future of glaciers can help people adapt to the realities of a changing climate (Peduzzi, Herold, & Silverio, 2010). To predict the future of a glacier, we perform a multiple regression using available data for glacier area, temperature, and precipitation to obtain a prediction equation. We then use the equation to extrapolate past data to predict the area of the glacier based on future values for temperature and precipitation. We apply this method specifically to predict the future of the Midtfonna glacier. Using two scenarios for projected changes in temperature and precipitation over the course of the next century from the *Intergovernmental Panel on Climate Change's* 2013 report on climate change (IPCC, 2013), we find the estimated year for when the Midtfonna glacier will disappear under each scenario.

Constructing and Applying the Mathematical Model of Glacier Retreat

In this article, we study and explain the relationship between various climatic factors and the ice mass of a glacier. To accomplish this goal, we construct a mathematical model of glacier retreat representing how various climatic factors affect a glacier's ice mass. In the following section, we explain how to use the tools of a multiple linear regression to set up and apply the model to a specific glacier.

Constructing the Model
Variables Included in the Model
The variables we chose to include in our model of glacier retreat are summarized in Table 1. The random variable is glacier ice mass, while the independent variables are the climatic factors: temperature, precipitation, local climatic phenomena, wind speed, and insolation. We chose to include these climatic factors because they have been shown to be highly correlated with changes in the ice mass of a glacier (Anderson et al., 2006; Bitz & Battisti, 1999; Letreguilly, 1988).

Table 1: Summary of variables included in the model of glacier retreat.

y- Random Variable	Variables Included in the Model
x_i- Independent Variable	
x_1	Temperature (°C)
x_2	(Precipitation (mm/m2)
x_3	Local Climatic Phenomena
x_4	Wind Speed (m/s)
x_5	Insolation (kwh/m2/day)

Glacier ice mass can be quantified in a variety of ways. Depending on the data available and purpose for applying the model, one can choose to use total glacier volume, total glacier area, terminus point, or mass balance as a measure of a glacier's ice mass in the model. Mass balance is better correlated to the climatic factors than total glacier area. This can be explained by noting that the rate at which a glacier's area will shrink under the influence of climatic factors depends on the relative thickness of the ice, whereas mass balance only measures the annual net loss/gain of snow and ice, making it much more sensitive to the climatic factors. However, glacier area is a better instrument to use for predicting the future of a glacier as it gives us an overall picture of a glacier's size (as opposed to mass balance which only offers the yearly ice budget of a glacier rather than a measure of its total ice mass).

Temperature can be measured in a variety of ways such as mean annual temperature or mean summer temperature (months designated "summer" will vary depending on the location of the glacier the model is being applied to). As the majority of the melting of a glacier's ice occurs in the summer months when temperatures are at their peak, summer temperature is better correlated to variations in the ice mass of a glacier than yearly temperature. Therefore, we recommend summer temperature be used in the regression model. Also, because the thickness of a glacier's ice helps determine the rate at which it melts, a delay in the effects of temperature on the glacier may need to be accounted for. Similarly, precipitation can be measured in a variety of ways, such as mean annual precipitation or mean winter precipitation (months designated "winter" will vary

depending on the location of the glacier the model is being applied to). As the majority of snow accumulation and formation of a glacier's ice occurs in the winter months, winter precipitation is better correlated to variations in the ice mass of a glacier than yearly precipitation. Therefore, we recommend winter precipitation be used in the regression model. Also, because snow takes time to compress into ice, a delay in the effects of precipitation on the glacier may need to be accounted for.

Local climatic phenomena are cyclical weather patterns capable of causing significant changes to climatic factors such as temperature and precipitation. Examples of local climatic phenomena are North Atlantic Oscillation, North Pacific Oscillation, Atlantic Multidecadal Oscillation, Pacific Decadal Oscillation, El Niño/La Niña, and monsoons. To measure a local climatic phenomenon, an index value representing the strength of the particular cyclical weather system is used. Depending on the location of the glacier, there may or may not be a local climatic phenomenon that influences the climate near the glacier.

Wind speed is included in the model, as wind is capable of removing snow from windward slopes. The removal of snow scours the ice on the slope, which causes it to become more reflective of the sun. Therefore, wind is able to affect both the accumulation and ablation of snow and ice.

Insolation is the last variable we have included in our model. Ice will melt faster with greater solar exposure. The unit used to measure insolation is kilowatt hours per square meter per day ($kwh/m^2/day$), which represents the amount of solar energy that strikes a square meter of the earth's surface over the course of a day.

Description of the Model
Linear Regression is a statistical tool that helps us analyze relationships between various components of a complex system, and develop methods of prediction for the output of the system. The first step in setting up the model for a glacier is to perform a multiple linear regression of the glacier's ice mass (the random variable) on the five climatic factors (the independent variables) and obtain a regression equation of the form

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_5 x_5$$

where y represents the glacier's ice mass, $x_1, x_2, ..., x_5$ represent the climatic factors listed in Table 1, and $\beta_0, \beta_1, ..., \beta_5$ represent the regression coefficients. We will use this regression equation to predict the random variable y, based on the value of the independent variables $x_1, x_2, ..., x_5$.

Once the linear regression equation has been set up, we test whether or not there is a significant linear relationship between the variables. To do this, we perform a hypothesis

test where the null hypothesis is H_0: $\beta_i = 0$ for all $i = \overline{1,5}$, meaning there is no linear relationship between the glacier's ice mass and the climatic factors with the significance level $\alpha = 0.05$. We then find the p-value for the test statistic. If the p-value is less than 0.05, we reject H_0 and conclude that there is a significant linear relationship between the glacier's ice mass and the five climatic factors.

Now, while the aforementioned hypothesis test establishes whether or not there is a significant linear relationship between the glacier's ice mass and all the climatic factors together, we also perform hypothesis tests to check whether or not there is a significant linear relationship between the glacier's ice mass and each of the climatic factors, given that all other climatic factors are already in the model. This process tests whether or not the inclusion of an additional independent variable into the regression improves the prediction of the random variable. Thus, for each $i = \overline{1,5}$, we perform an individual hypothesis test, where the null hypothesis H_0 is $\beta_i = 0$, meaning there is no linear relationship between the glacier's ice mass and the ith climatic factor. For each individual hypothesis test, we find the p-value for the test statistic with the significance level $\alpha = 0.05$. If the p-value is less than 0.05, we reject H_0 and conclude that there is a significant linear relationship between the glacier's ice mass and the ith climatic factor.

Next, we measure the strength of the linear relationship. We do this by calculating three values: the sample correlation coefficient r, the sample coefficient of determination r^2, and the adjusted r^2. The sample correlation coefficient r is a number between -1 and 1, which is an indicator of linear association between the random variable and the independent variables. The closer the absolute value of r is to 1, the stronger the linear association between the glacier's ice mass and the climatic factors. The sample coefficient of determination r^2 is a number between 0 and 1 representing the proportion of total variation in the random variable that is explained by the independent variables. However, as more independent variables are added to the regression, the r^2 increases regardless of whether or not the additional variable actually contributes to the variation in the random variable. To find the true amount of variation of the random variable that is explained by the independent variables, we look at the adjusted r^2, which is the un-inflated r^2 adjusted for the number of independent variable used in the regression. The closer the adjusted r^2 is to 1, the larger the proportion of total variation in the glacier's ice mass explained by the climatic factors.

The final step in our model is to check the assumptions of the regression. We will determine whether there is high correlation among the independent variables (multicollinearity), whether the regression model is a good fit to the data, and whether the data are normally distributed. To test for multicollinearity, for each regression coefficient we calculate the variance inflation factor (VIF), a measure of the increase in variance of an estimated regression coefficient due to collinearity. If all of the VIFs are less than 5, we conclude that there is not a high degree of multicollinearity in the model. However, if one or more of the VIFs are greater than or equal to 5, then we must decide what to do in order to reduce the multicollinearity between independent variables.

To check whether or not the regression model is a good fit to the data, we set up the residual plot. A residual plot free of any patterns indicates that the model is a good fit for the data. In order to check whether or not the data are normally distributed, we view the normal probability plot. A normal probability plot showing the data following a straight line with positive slope indicates a normal distribution of data. Once these assumptions of the regression are verified, and the previous steps of the model have been completed, we are able to verify the usefulness of the regression model.

Applying the Model
We applied our model of glacier retreat to study the Midtfonna glacier, located in Folgefonna National Park in Norway. Midtfonna is the smallest of three glaciers that make up the Folgefonna glacier (see figure 2), the other two being Nordfonna glacier and Sorfonna glacier. We chose to perform a multiple regression analysis on the Midtfonna glacier because its ice mass exhibits the most extreme response to changes in climatic factors.
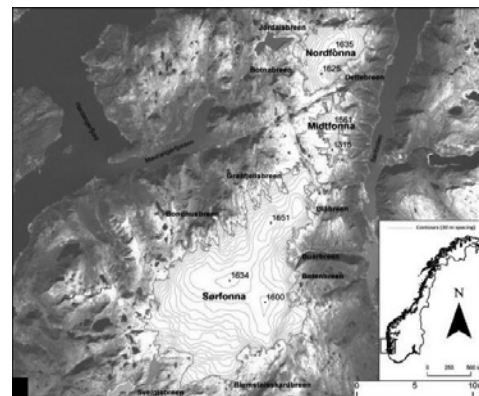
Figure 2: Folgefonna Glacier (Robson, 2012)

The random variable we chose to include in the regression was total glacier area, while the independent variables we included were the climatic factors: summer temperature (July and August mean), winter precipitation (October – April mean), North Atlantic Oscillation index (December – March mean), highest mean wind value (annual mean), and summer insolation (July and August mean). The North Atlantic Oscillation is a local climatic phenomenon that

affects Europe, among other areas, and causes cyclical precipitation increases and milder summers to occur in Norway.

We chose to perform two regression analyses. One analysis includes insolation, while the other does not. The reason for this is that we had insolation data for a much shorter time span compared to the data we had for the other climatic factors. The regression analysis that does not include insolation uses 50 years of data spanning the years 1962 – 2011, while the regression analysis that includes insolation uses only 21 years of data spanning the years 1985 – 2005.

We now discuss the analysis that does not include insolation. Table 2 is the regression summary output obtained from performing a multiple linear regression using 50 years of data for the Midtfonna glacier. The sample correlation coefficient r is represented in the table by the "Multiple R." From viewing the table, we find that the sample correlation coefficient r is 0.876. This tells us that there is a strong linear association between Midtfonna's total glacier area and the climatic factors included in the regression. We are also able to see that the adjusted r^2 is quite high at 0.746. Therefore, 74.6% of the total variation in Midtfonna's area is explained by summer temperature, winter precipitation, NAO index, and wind speed. The p-value of the regression is $1.01*10^{-13}$, which tells us that at least one of the independent variables, summer temperature, winter precipitation, NAO index, or wind speed, is contributing significant information to the prediction of glacier area. The individual p-values corresponding to each of the independent variables (0.0062, $8.75*10^{-6}$, 0.0124, $3.99*10^{-8}$) show that all four variables add important information to the prediction of glacier area in the presence of the other ones already in the model.

To check whether multicollinearity exists in the regression model, we computed the variance inflation factor for each independent variable. The variance inflation factors for summer temperature and wind speed at 1.224 and 1.174, respectively, show very slight multicollinearity. The VIFs for winter precipitation and NAO index at 3.307 and 3.06, respectively, show a higher degree of multicollinearity. Though the variance inflation factors for winter precipitation and NAO index show that the two variables are moderately linearly related, both VIFs are under 5, the threshold for severe multicollinearity.

To eliminate this redundancy in the model, we could remove the NAO index as a variable. However, our goal for this regression is to identify what percentage of the total variation in the glacier's total area is explained by the climatic factors, so, since multicollinearity does not affect the r^2, we decided to keep the NAO index in the model. As a consequence the regression coefficients of winter

precipitation and NAO index are unstable and therefore difficult to predict.

Table 2: Summary output for regression using 50 years of data (insolation not included)

Regression Statistics			ANOVA					
Multiple R	0.876060213			df	SS	MS	F	P-value
R Square	0.767481498		Regression	4	187.6755571	46.91889	37.13325	1.01623E-13
Adjusted R Square	0.746813186		Residual	45	56.85875114	1.263528		
Standard Error	1.124067526		Total	49	244.5343083			
Observations	50							
	Coefficients	Standard Error	t Stat	P-value	VIF			
Intercept	41.70276854	2.39016141	17.44767879	1.18418E-21				
Temperature	-0.410693454	0.143285726	-2.866255174	0.006295705	1.224739629			
Precipitation	-0.07034745	0.014028203	-5.014715756	8.75907E-06	3.30708961			
NAO Index	1.142103091	0.438773794	2.60294281	0.01247288	3.060629674			
Wind	-2.104659717	0.318853614	-6.600708364	3.99289E-08	1.174212775			

We verify the assumption of regression by viewing the residual plot (Figure 3) and normal probability plot (Figure 4). The residual plot is free of any patterns, meaning that the model is a good fit for the data; the normal probability plot shows data following a straight line, indicating a normal distribution of data.
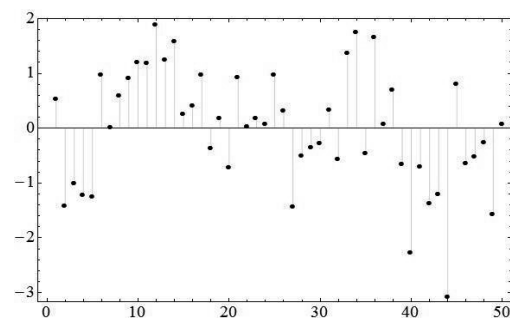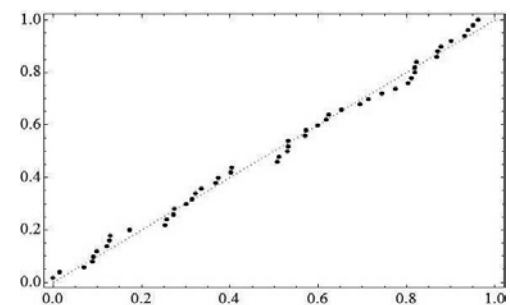

Figure 3: Residual plot

Figure 4: Normal probability plot

Table 3: Summary output for regression using 21 years of data (insolation included)

Regression Statistics		ANOVA					
Multiple R	0.933024962						
R Square	0.87053558		df	SS	MS	F	P-value
Adjusted R Square	0.827380773	Regression	5	47.4265877	9.485318	20.17239	3.55695E-06
Standard Error	0.685720704	Residual	15	7.053193251	0.470213		
Observations	21	Total	20	54.47978095			
	Coefficients	Standard Error	t Stat	P-value			
Intercept	32.96321585	5.226448145	6.307001415	1.40625E-05			
Temperature	-0.627686993	0.130206158	-4.820716651	0.000224581			
Precipitation	-0.069455514	0.019506829	-3.560574303	0.002846803			
NAO	2.950447141	0.530219486	5.564576969	5.41097E-05			
Wind	-1.4030554	0.474251036	-2.95846565	0.009763955			
Insolation	1.494641999	0.346932734	4.308160788	0.000621519			

Table 3 shows the regression summary output obtained from performing a multiple linear regression using 21 years of data for Midtfonna glacier. When we include insolation as an independent variable in the regression, we notice that the adjusted r^2 increases to 0.827. All of the p-values are also less than the significance level of 0.05. The residual plot and normal probability plot show that the assumptions of the regression analysis are verified. From applying our model of glacier retreat to study the Midtfonna glacier, we have shown that the climatic factors (summer temperature, winter precipitation, the North Atlantic Oscillation, wind speed, and summer insolation) are strong predictors of the glacier's total area.

Predicting a Glacier's Future
Our second goal for this article is to use regression analysis to predict the future of a glacier. We accomplish this by two methods, each differing in the way the ice mass of a glacier is predicted. The first method involves performing a time series regression to study how the ice mass of a glacier changes with the passage of time. The second entails using data from future prediction scenarios for temperature and precipitation in a multiple regression equation to predict when a glacier will disappear. For each method, we first outline the process of how the future of a glacier is predicted, and then present our results from applying the described method to predict the future of Midtfonna glacier.

Predicting a Glacier's Future Using Time Series Regression
Description of Time Series Regression
The first method we employ to predict the future of a glacier's ice mass is a time series regression, where the ice mass of a glacier is the random variable and the year the measurement was taken is the independent variable. We obtain a prediction equation of the form

$$y = \alpha + \beta x$$

where y represents the glacier's ice mass, x represents the year, and a and β represent the regression coefficients. We can use this prediction equation to find the estimated ice mass of the glacier for a given year by inputting the desired year into the equation and viewing the output. To determine the estimated year the glacier will disappear, we start with the year of the last available data point as the input for the equation. We then incrementally increase the year by 1 until the output of the equation, representing the estimated ice mass of the glacier, is less than or equal to 0. Thus, using the prediction equation we obtain an estimate for the year when the glacier will cease to exist.

However, to be able to make a prediction for the glacier's area with a desired probability (probability of 1- a, where a is the significance level), we need to compute a $(1 - a)100\%$ prediction interval estimating the actual future value of the random variable y. A prediction interval allows us to say that a single value for the random variable y at a point $x = x_0$ will fall within the interval with $(1 - a)100\%$ probability, where a is the significance level. Therefore, for a significance level of $\alpha = 0.05$, a 95% prediction interval tells us that the glacier's ice mass will take values in the interval with 0.95 probability.

Predicting Midtfonna Glacier with a Time Series Regression
Now that we have discussed how to predict the future of a glacier using a time series regression, we will present our results from using this method to predict the future of Midtfonna glacier. To estimate when Midtfonna glacier will disappear, we performed a time series regression with data from the years $1962 - 2011$ for Midtfonna's total glacier area. Figure 5 shows a graph of the regression line, between the words "Prediction Interval," obtained from the time series regression.
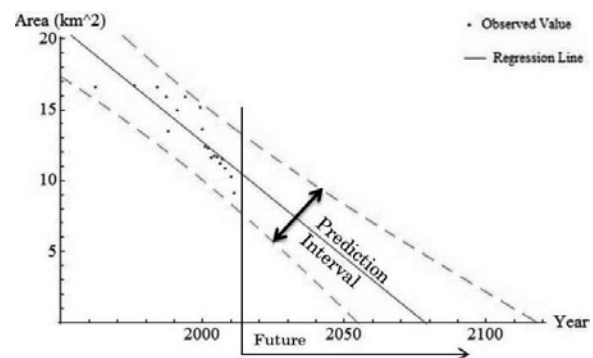
Figure 5: Graph of the time series regression line

Based on the time series regression, we estimate that Midtfonna will disappear by the year 2078. The graph also contains the observed values of Midtfonna's total glacier area, as well as a 95% prediction interval that we computed which spans the area between the two dashed lines. With 95% confidence we predict that Midtfonna glacier will disappear sometime between the years 2055 and 2118.

Predicting a Glacier's Future Using Multiple Regression with Climate Scenarios

Description of Multiple Regression with Climate Scenarios

The second method we employ to predict the future of a glacier is to account for different possible scenarios for the evolution of the climate over the next century and to incorporate them into our prediction equation. We first perform a multiple regression where a glacier's ice mass is the random variable; the year, summer temperature, and winter precipitation are the independent variables to obtain a prediction equation of the form

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$$

where y represents the glacier's ice mass, x_1 represent the year, x_2 represents summer temperature, x_3 represents winter precipitation, and β_0, β_1, β_2, β_3 represent the regression coefficients. The year is included as an independent variable so that we can use it as a counter to keep track of the year for which we are predicting the glacier's ice mass.

The second step of this method involves extracting the necessary data for temperature and precipitation from the available climate scenarios to use in the prediction equation. Suppose we have a 2012 scenario projecting a temperature increase of 3°C by 2100. To obtain the value of temperature for each year in the 2012 – 2100 interval, we must distribute the increase of 3°C over the time span of the projection. We break up the projected increase of 3°C into equally sized increments by dividing 3°C by the number of years in the span 2012 – 2100, which gives us an increase of 0.034°C per year. Obtaining the value of precipitation for each year in the 2012 – 2100 interval is found in a similar way, but with an additional step since the projection is expressed as a percentage. Suppose we have a 2012 scenario projecting a precipitation increase of 10% by 2100. Since the precipitation amount for the year 2011 might be an outlier, we will instead compute the average precipitation for the past decade (2001 – 2011). The average is found using 10 years of precipitation data in order to smooth out any outliers that may exist in the data and obtain a fair estimation of the "normal" amount of precipitation for the current time period. We then calculate 10% of this average and divide it by the number of years in the interval 2012 – 2100 to find the increase in precipitation per year.

Once we have obtained the projected yearly increase in temperature and precipitation, the next step is to calculate an average for both of these climatic factors that will be used as starting values in the prediction equation; we will call these averages our baselines. Continuing the example, because the projected changes in temperature and precipitation start from the year 2012, we will want to find

the average summer temperature and winter precipitation for the decade 2001 – 2011. The two averages are calculated using 10 years of temperature and precipitation data in order to smooth out any outliers that may exist in the data and obtain a fair estimation of the "normal" values of temperature and precipitation for the current time period. Since the baseline for precipitation was already found when we calculated the increase in precipitation per year, all that remains to be found is the baseline for temperature.

We can use these data and our prediction equation to predict the future of a glacier using scenarios projecting future temperature and precipitation. We continue to use the example to explain the next steps of predicting the future of the glacier. T_0 represents the baseline value for temperature; ΔT the increase in temperature per year; P_0 the baseline value for precipitation; ΔP the increase in precipitation per year; and i the year. The estimated ice mass of a glacier at year i, for i in the interval 2012 – 2100, is found by entering the following values into the prediction equation: the input for year is i; the input for temperature is $T_0 + (i - 2011)\Delta T$; the input for precipitation is $P_0 + (i - 2011)\Delta P$, where $i - 2011$ gives us the years since 2011. Starting with $x_1 = i = 2012$ and the corresponding values for temperature and precipitation in the prediction equation, the evolution of the glacier over time is found by incrementally increasing i by 1 and viewing the output of the prediction equation. This process of incrementally increasing i can be continued until the estimated ice mass of the glacier reaches zero at year i^* or the last year for which temperature and precipitation were projected is reached, which in our example is 2100. Thus, we either obtain the year i^* when the glacier will completely disappear, or we obtain the predicted value of the glacier's total area in 2100.

Predicting Midtfonna Glacier using a Multiple Regression with Climate Scenarios

To predict the future of Midtfonna glacier based on scenarios for future temperature and precipitation, we first performed a multiple regression using 50 years of available data spanning 1962–2011 for total glacier area, temperature, and precipitation. Included in the regression as the random variable was Midtfonna's total glacier area, while the independent variables were the year, summer temperature, summer temperature squared, winter precipitation, and winter precipitation squared. Because the year is such a strong predictor for the total glacier area of Midtfonna, the effects of summer temperature and winter precipitation on the glacier are overshadowed. To fix that problem, we made summer temperature and winter precipitation more prominent predictors by introducing the squared terms into the regression.

From this multiple regression we obtained the following prediction equation:

$$y = 291.497 - 0.149\,x_1 + 0.084\,x_2 - 0.017\,x_2^2 + 0.241\,x_3 - 0.0007\,x_3^2$$

where y represents Midtfonna's total glacier area, x_1 represents the year, x_2 represents summer temperature, and x_3 represents winter precipitation.

For this equation, we used two climate scenarios projecting future temperature and precipitation changes until the year 2100. These two scenarios (see Figures 6 and 7) were obtained from the *Intergovernmental Panel on Climate Change*'s 2013 report on climate change (IPCC, 2013). In scenario 1, the annual mean surface temperature and annual mean precipitation in Norway, the location of the Midtfonna glacier, is projected to increase by 1.5°C and 5%, respectively. In scenario 2, the annual mean surface temperature and annual mean precipitation in Norway are projected to increase by 4.5°C and 15%, respectively.
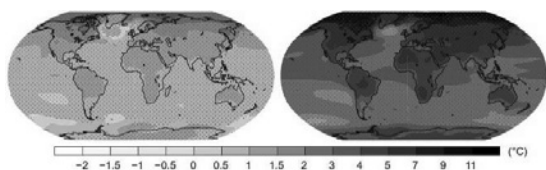
Figure 6: Projected change in annual mean surface temperature by 2100. Scenario 1 is on the left; Scenario 2 is on the right (IPCC, 2013).
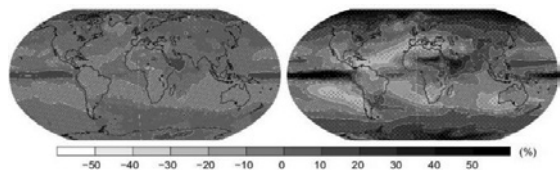
Figure 7: Projected change in annual mean precipitation by 2100. Scenario 1 is on the left; Scenario 2 is on the right (IPCC, 2013).

To use the data from these two climate scenarios in the prediction equation, we must distribute the projected changes in temperature and precipitation over the 2012 – 2100 interval. Breaking up the projected temperature changes for scenario 1 and scenario 2, we divide the 1.5°C and 4.5°C projected increases by the number of years in the 2012 – 2100 interval to get an increase of 0.017°C and 0.051°C, respectively, per year. To be able to break up the projected precipitation increases into increments, we must first find the baseline for precipitation, meaning we have to find the average winter precipitation over the interval 2001 – 2011. We calculated this to be 180 mm/m² per year. Now we compute the per year increase in precipitation for scenario 1 and scenario 2 by dividing 5% and 15% of 180

by the number of years in the interval 2012 – 2100, which gives us an increase of 0.1 mm/m² and 0.3 mm/m², respectively, per year.

The next step involves finding the baselines for summer temperature and winter precipitation, the values for temperature and precipitation that will be incrementally increased when predicting the future of Midtfonna glacier with the prediction equation. The baseline for winter precipitation has already been established at 180 mm/m². By calculating the average summer temperature for the years 2001 – 2011, we found the baseline for summer temperature to be 8°C.

We now present our results from using the climate data from each scenario in the prediction equation. Under scenario 1, with a yearly increase of 0.017°C in temperature and 0.1 mm/m² in precipitation, we estimate that the Midtfonna glacier will disappear by the year 2086. Under scenario 2, with a more significant yearly increase of 0.051°C in temperature and 0.3 mm/m² in precipitation, we estimate that the Midtfonna glacier will disappear sooner, by the year 2079. The seven-year difference between the predicted years the glacier will disappear under each scenario can be explained by noting that, while the increase in temperature is more dramatic in scenario 2, its effects on the glacier's area are mitigated by an increase in precipitation.

Conclusion

In this article we accomplished two goals. In order to better understand the effects of climate change on glaciers, we constructed a mathematical model of glacier retreat representing how changes in climatic factors, such as temperature and precipitation, affect the ice mass of a glacier. We applied our model to study the Midtfonna glacier, located in Norway. Using multiple linear regression we studied the effects of temperature, precipitation, the North Atlantic Oscillation, wind speed, and insolation on the total area of the glacier, and found that within our model these factors explained 82.7% of the total variation in Midtfonna glacier's area. By adapting the variables in the regression to reflect the geographic location of a glacier, our model can also be applied to other glaciers to determine what proportion of total variation in a glacier's ice mass is explained by the five climatic factors.

Our second goal was to create a method to predict the evolution of a glacier over time by using different climate scenarios projecting future temperature and precipitation. We found that a glacier's future could be predicted this way by performing a multiple regression using available data for glacier area, temperature, and precipitation. From this regression, we obtain a prediction equation that enables us to extrapolate past data to predict the area of a glacier based on future values for temperature and precipitation. We

applied this method to predict the evolution of Midtfonna glacier using two climate scenarios from the *Intergovernmental Panel on Climate Change's* 2013 report on climate change (IPCC, 2013). For each scenario, we found the estimated year by which the Midtfonna glacier will completely melt. Under scenario 1, with a local projected increase in temperature and precipitation by 2100 of 1.5°C and 5%, respectively, Midtfonna glacier is estimated to disappear by the year 2086. Under scenario 2, with a local projected increase in temperature and precipitation by 2100 of 4.5°C and 15%, respectively, Midtfonna glacier is estimated to disappear by the year 2079. Our method for predicting the evolution of a glacier can be applied to other glaciers, provided the necessary climate and glacier data, outlined in section 3.2.1, are available.

Our model of glacier retreat shows that climate change and the retreat of glaciers are inextricably linked. As the earth's climate currently undergoes significant shifts, the rate at which glaciers retreat is accelerating. The rapid melting of glaciers around the world is a serious issue, as negative repercussions for humans and animals follow from the rapid disappearance of glaciers. Alteration of delicate ecological systems and loss of habitat for numerous species, severe reduction of water supplies for irrigation and drinking supplies, loss of hydroelectric power sources, and rising sea levels are major problems that await us if glaciers continue to melt at an increasing rate. The methods we have presented for predicting the future of glaciers can help people prepare for the disappearance of an important source of life and adapt to the realities of a changing climate.

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About the Author

Robert Guillette is a senior studying Mathematics (major) and Computer Science (minor). This research was conducted under the guidance of Dr. Irina Seceleanu (Mathematics) during the summer of 2013; funding for the project was provided by an Adrian Tinsley Program Summer Research Grant. The results of this research were presented at the 2014 Joint Mathematics Meetings in Baltimore, MD and 2014 Posters on the Hill in Washington, DC.

A Narrative Review of the Intervention Techniques for Childhood Apraxia of Speech

Katherine Mahoney

Childhood Apraxia of Speech (CAS) is a speech disorder that affects development of the motor planning skills needed for the production of speech. According to prevalence data, CAS affects approximately two children per 1,000 (Bauman-Waengler, 2012, p.366). For normal speech production to occur, the brain requires an accurate, sequenced plan to coordinate the movement and sequence of muscles within the vocal tract. The development of motor planning for speech production is impaired in children with CAS, resulting in uncoordinated vocal tract muscle movements. This can lead to multiple speech sound errors which can create a speech pattern that significantly impacts the child's ability to communicate verbally. CAS is often described as a "motor planning disorder in the absence of motor weakness" (Velleman, 2003, p. 2). Therefore, the motor difficulties within CAS are not related to muscle tone but are related to the plan of (vocal tract) muscle movement, including sequencing and transitioning of vocal tract movements (Velleman, 2003, p. 3).

Historically, CAS has been termeddevelopmental apraxia of speech and developmental verbal dyspraxia (Teverovsky, Bickel, & Feldman, 2009, p. 95). Early terms for the disorder have included developmental articulatory dyspraxia, congenital articulatory apraxia and developmental verbal apraxia (Bauman-Waengler, 2012, p. 365). The term dyspraxia refers to an impaired praxis (the ability to plan for voluntary motor movement) and does not accurately reflect the severity of the disorder; therefore apraxia serves as a more appropriate term to assist in the labeling of the disorder (Velleman, 2003, p. 2). The use of the term developmental is also controversial because it denotes a disorder that will improve without speech-language therapy and is therefore hard to cover through insurance (Velleman, 2003, p. 4). Insurance companies have often denied covering all speech or language therapy that has been termed developmental (McCarty, 2013). Although CAS has been termed a developmental disorder, the nature of the disorder is also neurological (McCarty, 2013). The current term for the disorder, Childhood Apraxia of Speech, removes the "developmental" label because CAS differs from a developmental delay, and arises from abnormal physiological function in which the brain has difficulty motor planning for speech (McCarty, 2013). The prognosis of CAS is emblematic of the time in which CAS is diagnosed and the intensity of the intervention (Velleman, 2003, p. 8).

CAS is a complex speech disorder affected by many factors. Although CAS is a speech disorder that affects the motor planning skills for speech and the coordination of vocal tract muscle movements, the disorder does occur concurrently with phonological difficulties (Velleman, 2003, p. 2). There are many different symptoms that can occur with the disorder; however, there are no specific phonological characteristics that must be present in the diagnosis (Bauman-Waengler, 2012, p.368). The technical report for CAS produced by the American Speech-Language-Hearing Association lists the following segmental and suprasegmental characteristics of the disorder: "inconsistent errors on consonants and vowels in repeated productions of syllables or words, lengthened and disrupted coarticulatory transitions between sounds and syllables, and inappropriate prosody" (ASHA, 2007). Other characteristics that have been associated with the disorder include errors during the production of complex speech sounds, unusual errors that are not typical with other speech sound disorders, addition of speech sounds, omission of speech sounds, voicing errors, vowel errors, diphthong errors, sequencing difficulties, nasality difficulties, and groping behavior (Bauman-Waengler, 2012, p. 366). As mentioned previously, CAS can also occur with phonological and linguistic difficulties. Some phonological and linguistic characteristics that have been associated with CAS include "difficulty identifying rhymes and syllables" (Bauman-Waengler, 2012, p. 368). Aside from these symptoms, studies have revealed other possible characteristics that include academic difficulties and oral motor difficulties (Teverovsky et al., 2009, p. 95). Additionally, research has not yet identified an etiology for this disorder. The combination of factors makes the diagnosis of CAS difficult.

It is important to note that CAS is different than acquired apraxia of speech (AOS), a speech disorder resulting from neurological damage, including stroke or traumatic brain injury (Wambaugh, Nessler, Cameron, & Mauszycki, 2013, p. 84). Although both CAS and acquired apraxia of speech (AOS) are characterized by speech errors that stem from impaired motor programming rather than muscle weakness, there are important differences. (Bauman-Waengler, 2012, p. 395). An underlying difference between CAS and AOS is the etiology of the disorder. The etiology of AOS is damage to the central nervous system (Bauman-Waengler, 2012, p. 395). AOS may result from injury to the frontal lobe including Broca's area, the supplemental motor cortex, the basal ganglia and other cortical regions as well (Bauman-Waengler, 2012, p. 395). For a child

with CAS, there is no known cause or etiology for the disorder and a paucity of information makes the disorder difficult to diagnose. Another difference between AOS and CAS is the impact that CAS has on phonological and linguistic development (ASHA, 2007). CAS is a motor speech disorder that can co-occur with phonological impairments, where AOS is typically free of phonological or linguistic impairments unless AOS occurs with aphasia (Bauman-Waengler, 2012, 396).

Research of CAS has examined genetic and neurological components of the disorder. Some research has shown CAS to be "highly heritable" and that some children with a diagnosis of CAS have family members who also have speech and language disorders (Lewis, Freebairn, Hansen, Taylor, Iyengar, & Shriberg, 2004, p. 158). Researchers have studied a family pedigree of many members with a speech sound disorder. The pedigree, referred to as the K.E. family, has been shown to have characteristics of CAS including sequencing difficulties (Lewis et al., 2004, p. 158). Genetic testing of the K.E. family showed a mutation known as the FOXP2 gene (Lewis et al., 2004, p. 158). Neuroimaging of the K.E. family revealed frontal lobe and caudate nucleus abnormalities, two structures critical to speech production (Lewis et al., 2004, p. 158). The research of the K.E. family has led to further family pedigree research for families with members who have CAS. Studies on subsequent families have supported the previous findings of the K.E. family for a familial aggregation of CAS and other speech sound disorders (Lewis et al., 2004, p. 168). However, these studies do not provide enough support to consider the family pedigree findings as a recognized etiology for the disorder (Lewis et al., 2004, p. 169).

Further research has examined the neurological components of CAS. Neuroimaging studies have been reported as normal for two thirds of cases (Liégeois &Morgan, 2012, p. 444). An MRI for one case of CAS reported incomplete myelination (the insulated layer that forms around the axon of a neuron) (Liégeois & Morgan, 2012, p. 444). However, Liégeois and Morgan (2012) noted that one case is not enough evidence to generalize this type of neurological basis for all cases of CAS (p. 444). Neuroimaging research conducted by Lewis (2008) incorporated functional magnetic resonance imaging technology for children with childhood apraxia of speech. During the neuroimaging procedure, participants were asked to participate in a nonword repetition speech task (Lewis, 2008). Results of the neuroimaging study revealed activation patterns in Broca's area that are considered abnormal, including little activation and no activation (Lewis, 2008).

There is no standard intervtion approach to treat CAS; different approaches are recommended (Bauman-Waengler, 2012, p.

369). Murray, McCabe and Ballard (2014) conducted a systematic review of CAS intervention studies from 1970 to 2012 (p. 2). The authors reviewed 42 articles and examined the efficacy of the intervention approaches that were analyzed while excluding other systematic reviews from their study (Murray et al., 2014, p.8). The Cochrane journal conducted a systematic review which examined previous intervention studies of CAS though January 2007 (Morgan & Vogel, 2009, p. 103). The Cochrane systematic review examined 31 articles, and after careful consideration, all 31 studies were excluded (p. 106). The Cochrane review only pursued CAS intervention studies that were randomized control trials and quasi-randomized studies and none of the studies met their criteria (p. 105).

Systematic reviews contain collected and analyzed data from other researchers and provide high level evidence (Haynes & Johnson, 2009, p. 311). Systematic reviews "aim to answer a specific question in a way that minimizes biases present in the primary research and biases within the review process itself" (Garrett & Thomas, 2006, p. 97). A systematic review of interventions informs speech-language pathologists of the current research and allows them to make decisions consistent with the guidelines of evidence-based practice (Garret & Thomas, 2006, p. 102). A combination of current scientific evidence, client or stakeholder's preferences and the clinician's expertise determines the best treatment option (Haynes & Johnson, 2009, p. 418). Systematic reviews are critical to "validate research because causality between treatment and positive patient outcomes cannot be established on the basis of a single investigation" (Haynes & Johnson, 2009, p. 309). There are two schools of thought in regard to the concept of systematic reviews. According to Baker and McLeod (2011), systematic reviews contain a "relatively small portion of available studies" focused on published randomized controlled trials (RCTs) (p. 103). However, according to Garrett and Thomas (2006), a systematic review is not restricted to only experimental studies, but may also include non-experimental studies and case studies when appropriate (p. 98). For the purpose of this study, we are going to adopt the Baker and McLeod (2011) definition.

A systematic review does not typically cover studies of all Levels of Evidence and therefore lacks the "breadth and quality of all of the published evidence" (Baker & McLeod, 2011, p. 103). This can be problematic for a speech-language pathologist (SLP) trying to decipher the evidence of a particular intervention strategy, or research different strategies for children with rare cases (Baker & McLeod, 2011, p. 103). According to Baker and McLeod, a narrative review is an essential "complement to systematic reviews" which covers a broader scope of the published intervtion literature (p. 103). Narrative reviews provide comprehensive information to SLPs regarding the

available evidence of a wide range of intervention approaches (Baker & McLeod, 2011, p. 103).

The purpose of this study is to provide a narrative review of the current peer-reviewed literature of a variety of suggested CAS intervention studies. The current published peer-reviewed literature will be examined from 2009 to the present. The review will examine intervention approaches from all Levels of Evidence (i.e. systematic reviews and meta-analyses) of the most state-of-the-art research. A narrative review containing studies and research designs from all Levels of Evidence can reflect the quality of the available evidence for specific intervention approaches for CAS and is currently unavailable to clinicians at this time. This narrative review seeks to determine the extent and strength of the evidence for current intervention approaches for CAS, as well as the need for future research. All Levels of Evidence will be included in this study to provide comprehensive coverage of the current intervention studies of children with CAS (Baker & McLeod, 2011, p. 104). Systematic reviews and meta- analyses will be included because both types of studies are ranked as high-level evidence and provide rigorous information of available studies. Case studies will also be included in this narrative review as they provide information pertaining to the intervention approaches used for rare and unique clinical cases (Baker & McLeod, 2011, p. 103). This broad review attempts to provide SLPs and researchers with an extensive scope of the available intervention literature.

Levels of Evidence apply specific criteria to clinical studies and research, and assess the quality and credibility of the study (ASHA, 2004). Table 1 outines Levels of Evidence and its ranking according to the American Speech-Language-Hearing Association's (ASHA) guidelines. The chart is organized from evidence with the highest level of credibility to the least credible (ASHA, 2004). High-level credibility includes meta-analyses, and lowest level credibility includes expert committee reports, consensus and clinical experience (ASHA, 2004). Levels of Evidence are important for clinical decision making that adheres to evidence-based practice guidelines (ASHA, 2004). Table 2 provides the research designs of intervention studies for childhood apraxia of speech published from 2009 to the present (Baker & McLeod, 2011, p. 104).

Method
The following databases were used to search for peer-reviewed published studies: Medline, PsychInfo, Pubmed, Educational Resources Information Center (ERIC), Health Source Nursing Academic Edition, PsychARTICLES, Psychology and Behavioral Sciences Collection, and the American Speech, Language and Hearing (ASHA) online journals (Baker & McLeod,

2011, p. 105). The published intervention studies, 2009 to the present, were searched in order to analyze the most current interventions being implemented for childhood apraxia of speech. Key words and terms searched included combination-sof childhood apraxia of speech, developmental apraxia of speech, speech sound disorder, articulation, and phonological with treatment, intervention and therapy (Baker & McLeod, 2011, p. 105). A wide range of search terms including historical terminology (i.e. developmental apraxia of speech) were used to find all possible relevant studies. The search was conducted by hand and yielded 579 results. After duplicates were eliminated, the search yielded a total of 493 results. To narrow the search down to relevant studies, specific criteria were applied (Baker & McLeod, 2011, p. 105). Intervention studies were selected using specific inclusionary criteria. The search was confined to studies of interventions with children identified with a diagnosis of CAS. Studies written in English or translated into English were selected and international studies were considered. Studies which included children with cleft palate, hearing loss, Down syndrome, and stuttering disorders were excluded (Baker & McLeod, 2011, p. 105). Studies that did not meet the specific criteria were excluded. The search was accomplished by hand by searching through the titles and abstracts for each of the studies (Baker & McLeod, 2011, p. 105). The search was narrowed down to 13 studies relevant to the purposes of this narrative review.

Table 1 Levels of Evidence

Level of Evidence	Research Design
Ia	Well-designed meta-analysis of >1 randomized control trial (RCT)
Ib	Well-designed RCT
IIa	Well-designed control study without randomization
IIb	Well-designed quasi-experimental study (including single-subject designs)
III	Well-designed nonexperimental studies
IV	Expert committee report,consensus conference,clinical experience of respected authorities

*Levels of Evidence rankings according to ASHA's 2004 technical report for evidence-based practice in communication disorders (Baker &McLeod, 2011, p. 104).

Table 2 Levels of Evidence and Research Designs across the Intervention Studies for Childhood Apraxia of Speech Published From 2009 through 2014

Level of Evidence	Research Design	Number (%) studies
Ia	Meta-analysis	0
Ib	Randomized control trial	1 (7.7%)
IIa	Control study without randomization including Systematic & Narrative Reviews	2 (15.4%)
IIb	Quasi experimental study (including single-subject designs and multiple baseline designs)	8 (61.5%)
III	Case studies and correlational studies	2 (15.4%)
IV	Expert committee report, consensus conference, clinical experience of respected authorities	0

* Level of Evidence and research design across studies table was created following Baker & McLeod (2011) guidelines. Levels of Evidence provided are in accordance with ASHA's 2004 technical report for evidence-based practice in communication disorders.

Specific information was extracted from the remaining studies using the guidelines implemented in a narrative review conducted by Baker & McLeod (2011). This information included the "reference, year of publication, intervention approach, research design, participant numbers and age, mode of service delivery, study duration, and Level of Evidence" (Baker & McLeod, 2011, p. 105). Information pertaining to the statistical significance of the studies and the reported treatment outcomes were also extracted. Levels of Evidence were applied to the published intervention studies using the American Speech-Language-Hearing Association (ASHA) guidelines (ASHA, 2004). Levels of Evidence are configured by the research design and the outcomes of the study. The research designs considered for the study include systematic reviews, randomized control trials (RCTs), non-randomized (quasi-experimental) controlled trials, case studies, single-subject experiments, correlational designs and consensus findings.

Reliability

Interjudge reliability measures were conducted. The second author re-coded three articles that were randomly selected for Levels of Evidence data (Baker & McLeod, 2011, p. 106). Since the quantity of data was relatively small, statistical analysis of the re-coded data was not performed. Interjudge reliability measures resulted in 100 % agreement between both authors.

Results

The total search of online databases resulted in 493 results. Initially, 473 results were excluded because they were not relevant to the purpose of this narrative review. Further examination resulted in the exclusion of an additional seven studies. Reasons for exclusion varied, such as results that were not an intervention study, results were not specific to CAS, or results that did not meet the inclusionary and exclusionary criteria of the study. The online database search resulted in four studies that reported research related to the procedure of intervention approaches for CAS but were not specific to the intervention technique being used and as a result were excluded for this narrative review (Maas & Farinella, 2012; Maas, Butalla, & Farinella, 2012; Edeal & Gildersleeve-Neumann, 2011; Nordess, 2011).

The results of the online database search yielded 13 peer-reviewed intervention studies for CAS that met the inclusionary and exclusionary criteria of the current narrative review. The intervention studies consisted of the following research designs: systematic reviews, RCTs, quasi-experimental (single-subject designs), and case studies. The most frequently used research design was a single-subject design which included multiple baseline designs and AB designs. Single-subject designs accounted for 61.5 % of the intervention studies found. Subsequently, systematic reviews (15.4%) and case studies (15.4%) were the next type of research design frequently used. The results only consisted of one RCT (7.7%). Levels of Evidence were applied to each study according to the strength of the research design following the ASHA's 2004 technical report for evidence-based practice in communication disorders.

The treatment outcomes reported in the intervention studies varied across research designs. There was only RCT found in the database search and the study reported consistent outcomes (Dale & Hayden, 2013). For quasi-experimental research designs, five out of eight studies reported consistent outcomes (Ballard, Robin, & McCabe, 2010; Martikainen & Korpilahti, 2011; McCabe, Macdonald-D'Silva, van Rees, Ballard, & Arciuli, 2014; McNeill, Gillon, & Dodd, 2009; Preston, Brick, &

Landi, 2013). For case studies, one out of two studies reported consistent outcomes (McNeill, Gillon, & Dodd, 2009). Table 3 provides a chart of the results of the 13 peer-reviewed CAS intervention studies. Table 3 was configured following the guidelines of Baker & McLeod (2011). The chart provides the following information pertaining to the 13 studies: reference, intervention approach, research design, participant number and age, service delivery, study duration, consistent outcomes, statistical significance, and the Level of Evidence.

Discussion

The Level of Evidence reveals the strength of the research design. The research design of a case study is comprised of a lower ranking of evidence and does not provide as much support as other types of designs, e.g., single-subject designs and RCTs. The results of this narrative review reveal that CAS intervention studies are in a quasi-experimental research stage. The number of case studies is scarce and there are currently more quasi-experimental designs. Quasi-experimental designs portray stronger evidence than case studies because of their research designs and are therefore assigned a higher Level of Evidence. However, the designs of RCTs have more strength and high evidence compared to quasi-experimental designs and CAS intervention studies using an RCT design. This narrative review found only one published RCT in the last five years. Other narrative reviews and meta-analysis of speech and language disorders in children also report a lack of intervention studies with high-quality evidence and strong research designs (Baker & McLeod, 2011; Law, Garret, & Nye, 2004). In terms of strength, CAS intervention studies can greatly improve on the types of research designs currently implemented. Strong research designs like RCTs are connected to evidence that "yields a more credible, internally valid evidence base" (Baker & McLeod, 2011, p. 114). Although quasi-experimental studies like single-subject designs pose many benefits, RCTs are widely considered the "gold standard" design for intervention research (Byiers, Reichle & Symons, 2012, p. 398).

Single-subject designs (SSD's) for intervention studies in communication disorders serve many important purposes. The research design provides clinicians engaged in EBP with "helpful information about how and why an intervention might work" (Baker & McLeod, 2011, p. 114). SSD's can be beneficial for evaluating the effectiveness of interventions as well as comparing one intervention to another (Byiers et al, 2012, p. 412). SSD's are useful and "serve as a common framework for decision making" (Byiers et al, 2012, p. 412). However, a disadvantage of SSD's is that the results of the studies are difficult to generalize with larger populations (Paul & Cascella, 2007, p. 194). Additionally, quasi-experimental designs lack the quality of random assignment which is implemented in RCT studies.

Random assignment adds strength to the design of an RCT and does so by eliminating experimenter and participant bias (Haynes & Johnson, 2009, p. 323). The strength of RCTs and its high-level ranking can be attributed to the "double-blinding, randomization, and rigid experimental control in order to reduce any error in measurement of the dependent variable" (Haynes & Johnson, 2009, p. 326). Although SSD's serve a purpose in the field of communication sciences and disorders, they tend to lack the rigor of RCTs and do not provide the same strength of evidence. RCTs have a more rigorous research design and can provide clinicians with intervention studies that are highly credible. However, the results of this study reveal that SSD's are carried out more frequently than RCTs. RCTs may not be as popular as SSD's because RCTs are much more difficult to execute and complete, and are time intensive (Haynes & Johnson, 2009, p. 325).

Scientific evidence is a critical aspect of EBP. High-quality evidence serves many purposes in speech-language pathology. Evidence should be considered when choosing treatment plans because it helps ensure that the best outcomes for clients can be achieved (Paul & Cascella, 2007, p. 199). High-quality evidence not only helps serve the client, but also benefits the caregiver/stakeholder (Paul & Cascella, 2007, p. 199). High quality research can be provided to caregivers/stakeholders and the information regarding treatment options are available for them. Scientific evidence benefits the clinician by corroborating their decisions in therapy (Paul & Cascella, 2007, p. 199). High-quality research also adds credibility to the profession (Haynes & Johnson, 2009, p. 4). Current scientific research allows clinicians and researchers to stay up to date with current practices (Haynes & Johnson, 2009, p. 12). By improving research designs and researching current techniques, the profession finds ways to help improve client outcomes.

The strength of research designs should be considered when engaging in EBP. Scientific evidence is a large component of EBP in combination with client values and clinical expertise (Haynes & Johnson, 2009, p. 397). During clinical decision-making, clinicians should "identify the highest quality evidence directly related to the clinical question" (Haynes & Johnson, 2009, p. 402). EBP is a crucial and necessary component when deciding the treatment plan for a client (Haynes & Johnson, 2009, p. 417). Scientific evidence from research combined with the other components of EBP is important for achieving the best possible patient outcomes (Haynes & Johnson, 2009, p. 419). Speech-language pathologists must adopt the principles of EBP "to ensure that clients receive the best possible services informed by the highest quality of evidence available" (Johnson, 2006, p. 22). This current narrative review reveals that the evidence for CAS interventions is lacking in quantity

and quality (Johnson, 2006, p. 22). Future research for intervention studies with strong research designs and high-quality evidence is needed (Johnson, 2006, p. 22).

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About the Author

Katherine Mahoney is a senior majoring in Communication Sciences and Disorders. Her research project was conducted in the summer of 2014 under the mentorship of Dr. Suzanne Miller (Communication Sciences and Disorders). This project was fully funded by an Adrian Tinsley Program summer research grant. Katherine is deeply grateful to her mentor, Dr. Miller, for her continued support. Katherine plans to attend graduate school for Speech-Language Pathology in the fall of 2015.

Table 3
13 Intervention Studies for Childhood Apraxia of Speech

Reference	Intervention Approach	Research Design	Participant Number and Age	Service Delivery	Study Duration	Consistent Outcomes	Statistical Significance	Level of Evidence (ASHA)
Morgan & Vogel (2009)	No intervention approaches met the criteria for this systematic review # (*Cochrane Review*)	Systematic Review (RCTs)	N/A	N/A	N/A	N/A	N/A	IIa
Murray, McCabe, & Ballard (2014)	Various motor and linguistic based intervention approaches and AAC approaches	Systematic Review (All research designs)	23 articles spanning 42 years	Varied across studies	Varied across studies	Varied across studies	Varied across studies	IIa
Dale & Hayden (2013)	Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT)	Mixed Single Subject Design with random distribution (RCT) (2 groups of 2)	n = 4 (3;6-6;0)	1:1, speech-language pathologist (SLP), 50 min 2 x week	8 weeks (16 sessions)	Yes	No statistical analysis reported Raw data only	Ib
Ballard, Robin & McCabe (2010)	Treatment of enhancing intonation patterns	Single subject design with multiple baselines and behaviors across participants	n =3 (7;8-10;10)	1:1, SLP graduate students with supervision, 60 min 4x week	3 weeks	Yes	Normalized average duration of the first two syllables of real words [NORMDUR] ($p=.0001$) For all three participants Kruskal-Wallis Test	IIb
Gildersleeve-Neumann & Goldstein (2014)	Cross-linguistic generalization treatment:#1. Promoting child's meta- and perceptual awareness of speech goals 2. Drill play 3. Articulatory and phonological components with cueing strategies 4. Intensive production practice on targets 5. Minimal pair strategies.	Single subject with multiple probes across behaviors design	n = 2 (1 participant with CAS) (5;6)	1:1, SLP student with supervision, university, 50 min 2-3 x week	8 weeks	No	Effect size Cohen's d Target 1 ($d=2.35$) Target 2 ($d=3.173$) Overall ($d=2.644$)	

Table 3 (cont)
13 Intervention Studies for Childhood Apraxia of Speech

Reference	Intervention Approach	Research Design	Participant Number and Age	Service Delivery	Study Duration	Consistent Outcomes	Statistical Significance	Level of Evidence (ASHA)
Iuzzini & Forrest (2010)	Dual treatment approach. Goal is to decrease the variability of errors (stimulability training protocol [STP] and modified core vocabulary treatment [mCVT])	Single subject design with multiple baselines across subjects	n = 4 (3;7-6;10)	1:1, 10 min of STP, 45 min of mCVT	10 weeks (20 sessions)	No	"Substantial" decrease in variability of errors No statistical analysis provided	IIb
Lagasse (2012)	Melodic Intonation Therapy (MIT)	Single-subject design with an AB design	n = 2 (5, 6)	1:1, Board certified music therapist, home, 40 min 1 x week. Participants also continued to receive treatment session from their typical speech-language pathologist as usual concurrently with the MIT sessions	4 weeks	No	($p > .05$) Statistics applied were non-parametric. Wilcoxon test used. Significance only reported as "p > .05" (No actual significant data)	IIb
Martikainen & Korpilahti (2011)	Combination of Melodic Intonation Therapy (MIT) and the Touch-Cue Method (TCM)	Single subject design with ABA design	n = 1 (4;7)	1:1, SLP, 30 min, 6 week sessions including a 6 week withdrawal block	18 sessions per 6 week block including a 12 week follow up	Yes	Generalized Cochran-Mantel-Haenszel statistics for repeated measures used for statistical analysis. Percent of correct vowels (PVC) following MIT block (p =.033) (PVC) following TCM during follow-up (p = .019) Percent of correct consonants (PCC) 6 weeks after MIT block (p = .000) (PCC) during TCM block (p = .003)	IIb

Table 3 (cont)
13 Intervention Studies for Childhood Apraxia of Speech

Reference	Intervention Approach	Research Design	Participant Number and Age	Service Delivery	Study Duration	Consistent Outcomes	Statistical Significance	Level of Evidence (ASHA)
McCabe, Macdonald-D'Silva, van Rees, Ballard, & Arciuli (2014)	ReST intervention: Goal is to target the production of lexical stress	Single subject design with an AB design	n = 4 (5;5-8;6)	1:1, SLP 60 min 4 x week	3 weeks (12 sessions)	Yes	No statistical analysis reported. Raw data and percentages of correct vowels, consonants, and stress patterns reported.	IIb
McNeill, Gillon, & Dodd (2009)	Integrated phonological approach: 1. Decrease speech error patterns 2. Increase phonological awareness 3. Increase letter-sound knowledge	Single subject with an AB design	n = 12 (4-7)	1:1, SLP or SLP students with supervision, home or school, 45 min 2 x week per 6 week session including a 6 week withdrawal bloc	18 weeks	Yes	Suppression of two speech error patterns ($p < .001$) and ($p < .001$) Paired t tests used to analyze data over therapy period	IIb
Preston, Brick, & Landi (2013)	Ultrasound biofeedback	Single subject design with multiple baselines across behaviors	n = 6 (9;10-15;10)	1:1, SLP, 60 min 2 x week	10- 16 weeks (18 sessions)	Yes	($p = .028$) Non-parametric Wilcoxon test used.	IIb
McNeill, Gillon, & Dodd (2009)	Integrated phonological approach	Case study with a longitudinal design	n = 2 (4;5)	1:1, SLP, home, 18 total hours of intervention	18 total hours of intervention	Yes	No statistical analysis provided. Percentages of consonants and vowels correct were reported	III
Vashdi (2013)	Verbal Motor Learning (VML) using the Distal Dynamic Stabilization Technique (DDST): 1. Decrease vocal intensity 2. Differentiation of low and high pitch 3. Reduce word duration	Case study	n = 1 (14)	1:1, VML therapist, 30 min 1 x week, with home practice	4 weeks	No	Paired t tests were used for statistical analysis Word length ($p < .001$) Vocal intensity ($p < .001$) Frequency ($p < .0001$)	III

In a Right State of Mind: An Analysis of Cognitive and Linguistic Function Following a Rare Case of Atypical Language Dominance in Aphasia

Emily Manton

Introduction

When thinking about the human brain, it is possible to compare its structural importance to that of a working machine. In order for meaningful function to be executed, the networks within the machine's design must also be operative. Similarly, the brain's capacity to create and execute meaningful communication is dependent upon the functionality of its individual units. Extensive research has found that in 97% of people worldwide, language is typically carried out by the left cerebral hemisphere. Data regarding lesions or injury to this side of the brain has been readily documented. However, for the 3% of individuals who demonstrate "atypical cerebral dominance," or the execution of language from the right hemisphere of the brain, literature is scarce. Therefore, the purpose of this empirical prospective case study was to document the cognitive and language functions of a 59-year-old male who developed a type of language disorder ("aphasia") following a right hemisphere stroke.

Clinical evidence supporting the phenomenon of cerebral dominance came as early as 1861, when physician Paul Broca localized the centers for language function to specific regions in the left cerebral hemisphere for the majority of the population. His argument for asymmetrical hemispheric function was established through studies on left hemisphere lesions in which correlations between the absence of motor speech and damage to this area were observed (Coppens, Papathanasiou, & Potagas, 2013). Broca's discovery of the interrelationship between handedness and cerebral dominance has since prompted extensive studies on the brain's ability to create and execute language and has led to the term "Broca's aphasia" for certain forms of the disorder. Aphasia is generally defined as "an acquired language impairment occurring as the result of deficits in the language-dominant hemisphere of an individual" (Coppens, Papathanasiou, & Potagas, 2013).

According to Bhatnager (2013), and Coppens, Hungerford, Yamaguchi, & Yamadori (2002), the right hemisphere is specialized for language functions that include an individual's ability to comprehend abstract notions, recognize visual and spatial concepts, and regulate and express emotion. It has been maintained that individuals who possess right hemisphere dominance demonstrate a pattern of neural organization different from their left hemisphere dominant counterparts. As a result, the manifestation of deficits following damage to these areas differ from those associated with typical left hemisphere lesions (Knecht et al., 2002). Aphasia resulting from right hemisphere damage is characterized by components including halting, ungrammatical speech, neglect of the left side, and visuospatial deficits (Bhatnager, 2013). For those who are left hemisphere dominant, damage would generate deficits in written and verbal abilities in addition to the auditory comprehension of language (Bhatnager, 2013).

As a result of Broca's findings regarding neural function, studies have sought to explore the concept of brain lateralization as it relates to motor control and language. Lateralization may be defined as "hemispheric superiority for serving language" (Bhatnager, 2013). Typically, in 96% of people worldwide, language function is carried out by the left hemisphere (Rasmussen & Milner, 1977). Evidence supporting this high percentage derives from the high incidences of aphasia resulting from left hemisphere damage, as well as a lack of research corresponding with aphasia following right hemisphere lesions. In a study completed by Rasmussen and Milner (1977), the language centers of both dominant hemispheres were evaluated through a sample of 140 right-handed individuals. Their outcome asserted that of these subjects, only 4% represented language function in the right hemisphere. The findings correspond with data compiled during a systematic review of 588 individuals undergoing Wada tests in order to document language and memory lateralization. Of these individuals, 6% were classified as right hemisphere dominant (Moddel, Lineweaver, Schuele, Reinholz, & Loddenkepmer, 2009). The frequency of right-hemisphere cerebral dominance is approximately 1 in 10 individuals (Knecht, Jansen, Frank, Randenborgh, Sommer, Kanowski, & Heinze, 2002). Although previous research has suggested the appearance of aphasia in right hemisphere individuals is more prevalent in left-handers, recent data compiled by Morrow-Odom & Swan (2013) demonstrates that this type of manifestation is still considered a rare clinical occurrence. Therefore, the minute percentage of individuals who meet this criterion are recognized as atypical. Previous research has found the presence of apraxia to commonly occur in right-handed individuals following left cerebral hemisphere lesions. Apraxia may be defined as an

"inability to perform or inappropriateness in performing actions that cannot be attributed to paralysis or other primary motor deficits, nor to impaired comprehension or motivation" (Archibald, 1987). However, the documentation of lesions in left-handed individuals, has found that in cases of right hemisphere damage, the association between aphasia and apraxia is rare. According to Archibald (1987), and Margolin (1984), this is due to the variable atypical representation of language in these individuals. Furthermore, because apraxia has typically been associated with aphasia from left hemisphere damage, research suggests the possibility of shared neural structures between the two (Archibald, 1987). For individuals who are atypically lateralized for language, the representation of language and praxis are thought to be neurologically independent. These findings have prompted researchers to further examine the characteristics associated with reversed hemispheric organization. In a study completed by Archibald (1987), two left-handed patients with right hemisphere damage were evaluated. Following the administering of the Rey-Osterrieth Figure Test, data for impaired visuospatial function was noted. In cases of atypical hemispheric functioning, typical right hemisphere tasks such as visuospatial and memory skills follow a pattern consistently documented in left hemisphere damage. These findings therefore, provided evidence to argue against the presence of reversed cerebral lateralization in both individuals. Given the presence of reversed lateralization, the execution of these tasks would have been intact (Archibald, 1987).

Although previous research demonstrates the rare but possible occurrence of atypical language lateralization, literature regarding knowledge of how these communication breakdowns manifest following a diagnosis of aphasia is lacking. According to Knecht et al., (2003) the limitations in the current research correspond to our preliminary knowledge of right-hemisphere language dominance and underlying mechanisms. Further knowledge is dependent upon the documentation of individual cases. With an estimated 50 million Americans currently experiencing cognitive communicative disorders (Bhatnager, 2013), these findings have direct applications to the clinical understanding of how the brain executes language in these individuals.

Purpose
Specifically, this study sought to determine the following: To what extent has the right hemisphere (RH) preserved function? Has the left hemisphere (LH) assumed control over the execution of typical RH tasks? Given that the language areas of the RH are damaged, how do these deficits differ from those seen in typical LH aphasia?

Methodology
This research was guided by a prospective single-subject study. As evidenced by Paul & Cascella (2007), single-subject designs are significant in research that is focused on low-incidence disorders. By adopting this method, it was possible to construct an in-depth analysis of the participant's skills from a collection of qualitative and quantitative data. Given the limited amount of cases for atypical language lateralization, this design was implemented in order to develop a greater understanding of how the brain executes language in these individuals.

Participant
The participant (PG) was a 60-year-old male residing at the Royal of Cotuit Nursing and Rehabilitation Center in Mashpee, MA. At the time of the study, PG was status post RH cerebral vascular accident (stroke) with diagnosed Broca's aphasia and accompanying left hemiparesis (left-side weakness). Information concerning PG's medical history and lesion location was requested and acquired from the facility at which testing took place. In December 2012, PG was admitted after being found unresponsive with left-sided weakness. An imaging method known as computerized tomography (CT) was administered in order to form a detailed scan of PG's neural (brain) structures from the top of the brain to the bottom. The scans noted the presence of cerebral infarctions, a form of stroke caused by the inability of the blood vessels to supply blood to the brain. Affected areas of the brain included the inferior (lower) right frontal lobe, anterior (front) temporal lobe, and a structure responsible for the transportation of blood to the brain known as the middle cerebral artery (MCA). The presence of swelling was reported on the left lateral ventricle; however, there was no indication of a midline shift, meaning that pressure did not cause PG's brain to shift beyond the central line. Additional lacunar infarcts or strokes in the deeper structures of the brain were observed within a neural structure called the corona radiata. Hypodensities, or areas of softened brain tissue, were reported in the white matter of both cerebral hemispheres as a result of these lacunar infarcts.

Carotid Doppler testing was performed in order to assess blood flow in the carotid arteries of PG's neck. Results found 19% stenosis (narrowing) of the right internal carotid artery and 49% stenosis of the left internal carotid artery. A video swallow completed by speech pathology found the development of pneumonia (PNA) in the left lower lung (LLL), and mild-moderate oropharyngeal dysphasia, a disorder that creates difficulty in initiating a swallow. Reports of the neurologist findings indicated that PG was mute but able to follow commands. There was no documented speech-language evaluation report at the time of testing. Preceding the occurrence of his stroke, PG had no known history of

brain injury. However, a history of cardiac related concerns including coronary artery disease (CAD), myocardial infarction (heart attack), and cardiomegaly (enlarged heart) were noted. Additionally, an above the knee amputation (AKA) following a blood clot to a vein in the left leg was recorded. Prior to his stroke, reports indicated the heavy use of cigarettes and alcohol.

Materials and Procedures

In order to address the research questions, language and cognitive abilities were examined through a battery of manual and iPad related tests. To establish inter-rater reliability for measures requiring subjective judgment of accuracy/inaccuracy, two examiners were used. Following testing, the obtained data was categorized into typical right and left frontal, parietal, and temporal functions and used to examine the functionality of skills typically associated with the right hemisphere. Measurements of frontal lobe functions included tasks associated with gesture recognition, the sequencing of complex movements, executive functioning and selective attention. Tests associated with functions localized to the temporal lobe assessed the recall of nonverbal stimuli including musical melodies, recognition of color, auditory comprehension, and word recognition. Parietal lobe data focused on spatial and right/ left side awareness as well as visuospatial ability, constructional skills, writing, and reading comprehension. In addition to these assessments, a test of oral and limb apraxia was administered in order to document components of PG's respiratory and non-respiratory oral praxis (movement) and ideomotor (involuntary motor) skills. Given that our participant was reversed for language production and comprehension, through these tests we would expect to see the execution of tasks typically localized to the right hemisphere to be intact. This would indicate the control of the LH over these abilities.

Frontal Lobe Tests

Stroop Color and Word Test. The Stroop Color and Word Test (Golden & Freshwater, 2002) is a neuropsychological measure designed to assess executive functioning in addition to selective attention and cognitive flexibility. The participant was presented with a series of words in one of four colors: red, yellow, green or blue. Given a time limit of 30 seconds, PG was asked to identify the color of the words as quickly as possible. As the stimuli was presented one at a time, PG needed to correctly identify the first word before proceeding to the next. This test was administered twice, once with no interference and once with. In addition, the number of items correct was recorded and compared with a possible score of 20. Lower scores indicated poorer performance.

Alternating Trail Making Test. The Alternating Trail Making Test (Lease, 2011), created as a measure for visual attention and task, presented PG with a series of randomized letters and numbers displayed on the iPad. Stimuli included letters A-L and numbers 1-12. PG was asked to connect the stimuli in order, alternating between letters and numbers (1, A, 2, B, etc.). Poor performance indicated impairment localized to the frontal lobe.

Forward and Backward Manual Visual Span. The Manual Span (WhiteAnt Occasional Publishing, 2014) measures executive function and selective attention and sequencing. PG was presented with a series of blocks displayed on the iPad. Following the examiner's model, he was asked to repeat the sequence in the same succession as the model. In the administering of the Backward Span, PG was presented with the same series of blocks. However, in following the examiner's model, PG was asked to tap the blocks in the reverse order starting with the last block the clinician had touched and ending with the first. Performance and timing were recorded and scored out of a 5 on both the forward and backward subtests.

Boston Assessment of Severe Aphasia (BASA): The gesture recognition subtest taken from the BASA was administered as a measure for recognition of nonverbal stimuli. PG was asked to match two pictures to their appropriate gestures. Answers were scored as fully communicative affective (G2A) or partially communicative affective (G1A). In instances where perseveration or the repetition of a response was noted, "P" was recorded. Given the influence of aphasia on PG's verbal abilities, all answers were marked as "G" for gestural response.

Temporal Lobe Tests

Cognitive Linguistic Quick Test (CLQT): The story-retelling subtest from the CLQT was administered to PG as a measure for auditory comprehension (a typical LH function). Following the examiner's verbal recount of a story, a series of 6 paired yes/no questions were presented to PG. In order to attain a correct response, PG was required to accurately answer both questions in a pair. The maximum score for this subtest was a 3 with poor performance indicated through a lower score.

BASA: The BASA was administered to identify preserved auditory comprehensive skills by scoring PG's gestural, perseverated, and affective responses on subtests that required the identification of the correct month following verbal cuing. In addition, PG was asked to follow a series of verbal commands and match pictures of various actions to corresponding words.

BDAE: Auditory and verbal comprehension was assessed through subtests including word discrimination, complex

ideational material, and understanding written language. For these tasks, a series of yes/ no questions were presented to PG regarding implied information not readily in view. In addition, PG was administered a list of words verbally and asked to match them to corresponding pictures. Scores for these functions were recorded and compared to a percentile norm. Color recognition (typical RH task) was also measured through a subtest that required PG to identify and match a series of colors given verbally to corresponding pictures. Scores were reflected out of a possible 12 points.

Aphasia Diagnostic Profile (ADP): The recognition and recall of musical tones (typical right hemisphere task) was assessed through a subtest that required PG to recognize and produce a series of tunes including "Happy Birthday," "Rock-a-Bye Baby," and "America, The Beautiful." For each song accurately recognized, produced, and carried, 3 points were given. Scores reflected a maximum of 9 points. The understanding stories subtest of the ADP was administered as well a measure for auditory comprehension. Three stories, labeled "A," "B," "C" were given verbally to PG and followed by a series of yes/ no questions about stated and implied information. A maximum score of 10 was possible.

Parietal Lobe Tests

CLQT: As a measure of visuospatial abilities and neglect, the symbol cancelation subtest was administered. With a time constraint of 2 minutes, PG was given a model symbol and asked to eliminate all identical symbols on a following page. Performance was timed and scores were compared with a criterion cut score for age.

BASA: A subtest that required PG to reproduce the drawing of a man following a model was timed and scored according to his gestural, perseverated, and affective responses. Poor performance for this task was indicated through missing body parts or neglect to one side of the figure. This subtest was used as a measure for constructional and visuospatial abilities. Additionally, a subtest for writing (typical LH task) was administered.

BDAE: Body part identification and right/left discrimination components of the BDAE were given as assessment measures for spatial awareness and neglect. For the L/R awareness subtest, scoring reflected a maximum of 20 points. Body part identification was scored out of 18. Missed or inaccurately identified body parts demonstrated poor performance.

Clock Drawing Test Protocol: This test was administered on the iPad as a measure of neglect. PG was asked to draw a clock and place the hands at the time ten after eleven. Scoring reflected the correct orientation, representation, and legibility of the clock.

Findings

Frontal Lobe Findings

Overall findings of the frontal lobe indicated that specific skills associated with typical right hemisphere function were intact. Data obtained from the gesture recognition subtest of the BASA demonstrated a maximum score of G2A on both stimuli. On the Manual Visual Span, PG obtained a span of 4/5 on both the forward and backward components. In terms of standard scores for this test, a normal forward span is considered 5 while a normal backward is 4. PG scored one below the standard for forward and within norms for backward when he was asked to manually reproduce a pattern, in the reverse order, from memory. On the Alternating Trail Making Test, scores were dependent on the ability to alternate lettered and numbered blocks in an organized fashion. Difficulty in alternating stimuli into a coordinated sequence was noted. PG organized numbers and letters separately and in some instances misplaced or excluded blocks. Finally, data obtained from the Stroop Color and Word Test demonstrated that when no interference was presented, PG correctly matched 20 targets within the time allotment of 30 seconds. With interference from color, PG demonstrated a score of 2/20 correct in 30 seconds.

Temporal Lobe Findings

Following temporal lobe testing, the obtained data was classified into either typical right or typical left hemisphere function. On the assessment of auditory comprehension (a typical left hemisphere task), a series of subtests from the BASA, ADP, CLQT and BDAE were administered to PG. The largest number of deficits noted were those found in tasks where PG was required to answer a series of questions following the examiner's verbal recount of a story. On these tasks, significant perseveration was noted in PG's continuous response of "yes." Difficulty in this skill was reflected in the story recall subtest of the CLQT, for which PG scored a 0/3, as well as an ADP subtest for which a score of 0 was obtained for all three stories. In instances where PG was required to match written words to their corresponding picture, he was able to do so provided there was visual stimuli present. This is illustrated in his score of 9/10 on the word recognition subtest of the BDAE and 2/2 on the written word to picture portion of the BASA.

Testing on typical right temporal lobe functions were indicated through subtests of the BDAE and ADP. In terms of color recognition, PG scored a maximum 12/12 through his accurate identification of all colors. His recognition and recall

of musical tones is reflected in a score of 3/9. In regards to the recognition of tunes, PG recognized "Happy Birthday," "Rock-a-Bye Baby," and "America, The Beautiful." In addition, he was able to produce the tunes in unison with the examiner. However, when the examiner faded cuing, PG was unable to continue the melody alone.

Parietal Lobe Findings

Overall data analysis for parietal lobe testing indicated that typical right hemisphere function for this area was intact. Data obtained from Clock Drawing demonstrated PG's acknowledgement of numbers on both sides of space. However, in terms of the correct representation of time, PG scored a 0/1. Instead of placing the hands at the correct time of 10 past 11, PG placed the hands at 3 o'clock. On symbol cancellation, PG finished in 1:02 seconds with a score of 11 and paid adequate attention to symbols on both sides of space. When compared to the criterion cut score for his age, his performance was considered within normal limits. On testing that assessed visuospatial and constructional skills, PG demonstrated awareness of both sides of space by producing complete pictures that represented both the left and right sides of the body. On Body Identification on the BDAE PG scored a 16/18, placing him in the 60th percentile for aphasia severity. PG's performance on the writing subtest of the BASA was reflected in his score of 0/1. During this assessment, PG shifted from print to cursive resulting in a signature that was partially illegible.

Discussion

This case study sought to measure the cognitive and language function of both the right and left cerebral hemispheres in order to determine the extent to which PG's left hemisphere may have lateralized typical RH tasks. Results indicated that although the participant experienced damage to areas of both the frontal and temporal lobe, typical right hemisphere cognitive skills associated with these areas appeared intact.

Through frontal lobe data, we found functions of non-verbal communication and visual memory to be intact and maintained by PG's LH. Following the administration of the Span Test, it was noted that PG scored within norms for backward visual span where he was asked to manually reproduce a pattern from memory in the reverse order. Additionally, during the gesture recognition subtest of the BASA, PG was adequately able to match picture stimuli to their corresponding gestures. Given PG's diagnosis of right frontal damage, the ability to recognize gestures should have been impaired. Poor performance on the Stroop Word and Color as well as the Alternating Trail Test provided further evidence for PG's reversed cerebral lateralization. Deficits in selective attention were documented

following the completion of Stroop. In the presence of interference, PG was unable to accurately identify the targets. In addition, his continuous hitting of the target "yellow" even when "yellow" changed to a new color demonstrated the presence of perseveration. Perseveration may be defined as the "uncontrolled and unaware repetition of an earlier response after a change in stimuli tasks" (Bhatnager, 2013). PG's inability to switch from one stimulus to the next indicated that he was unaware of his error. Deficits in the ability to sequence complex movements was also noted as PG was unable to integrate numbers and letters into an ordered pattern during the Alternating Trail Making Test.

Data compiled from temporal lobe assessments demonstrated that functions of color recognition and recognition of musical tones were intact and maintained by PG's LH. Though PG was unable to carry a tune on his own during the singing portion of the ADP, his recognition of the three songs and attempt to produce the melody in unison with the examiner indicated that this skill was preserved. These findings, combined with his color recognition scores on the BDAE, demonstrated that the LH was processing and executing these typical RH skills. Furthermore, the data from these subtests coincide with the results of PG's CT scan documented infarctions to the anterior temporal lobe. Given this type of damage, deficits in these two temporal functions should have been noted. In addition to musical and color recognition, an assessment of auditory comprehension (typical LH task) was conducted. In cases of typical Broca's aphasia following LH damage, auditory comprehension is relatively spared (Coppens, et al., 2013). However, in the presence of reversed cerebral lateralization, we expected that deficits in PG's auditory comprehension skills would be impaired. Analysis of data obtained from subtests of the BDAE, ADP, CLQT, and BASA established deficits in PG's ability to separate and identify stimuli following verbal input. Impairments in PG's use of contextual information in the interpretation of events were also noted, as PG was unable to listen to a story or paragraph and process its events. Perseveration was observed across all tasks that involved PG to answer yes/no questions following a story. In these instances, PG responded with a continuous "yes." These findings correspond with deficits to the left temporal lobe, a characteristic of typical Broca's aphasia. However, because of PG's pattern of reversed cerebral dominance, these findings indicate damage to PG's right temporal lobe.

In the distribution of tests associated with parietal lobe functions, it was expected that following the completion of these tasks, the presence of hemispatial neglect would be noted. Neglect may be defined as "the inability to detect, identify, or move objects in the contralesional (left) side of

space, even in the absence of sensory or motor deficits (Saj, Fuhrman, Vuilleumier, & Boroditsky, 2014). Following right hemisphere lesions, these common deficits interfere with the individual's ability to generate normal representations of contralesional figures (Bhatnager, 2013). In the analysis of the findings however, PG's ability to acknowledge both sides of space on subtests such as clock drawing and symbol cancellation indicated that his internal representation of objects and people in space were intact. Additionally, PG's detail to the left side of his drawing in the BASA subtest indicated the absence of neglect. The implications of this data correspond with an earlier research question regarding the nature of PG's RH following his stroke. Due to the absence of neglect in all of the associated tasks in addition to PG's medical reports, it can be determined that the typical RH skills of spatial awareness and constructional ability remained undamaged. Following our participant's performance on the writing subtest, results indicated the possible presence of apraxia, a disorder characterized by distorted, imprecise, or incomplete letter formation (Bhatnager, 2013). However, following testing it was taken into consideration that PG's left side hemiparesis (weakness) requires him to write with his right non-dominant hand. In addition, the CT scan administered prior to testing did not note any damage to the left parietal lobe, the area in which writing ability is localized.

As mentioned above, the presence of apraxia often manifests following brain lesions localized to the LH in both right and left handed individuals. Data obtained from the TOLA indicated components of oral apraxia in PG. His performance and results on the non-respiratory component of this test correspond with his atypical representation of language in the right hemisphere. According to Archibald (1987), the representation of praxis or ability to perform learned gestures is typically localized to the left hemisphere. Some individuals, though rare, have been found to represent both language and praxis in the right hemisphere (Archibald, 1987). Following the distribution and completion of the TOLA, PG's inability to accurately execute non-respiratory tasks such as "bite an apple" indicates the lateralization of praxis in addition to language to his RH. Following the completion and analysis of cognitive and linguistic testing, the data demonstrated that PG experienced a severe Broca's aphasia with components of oral apraxia and agraphia, as well as auditory comprehension deficits. In addition, the findings indicated that PG's LH had assumed control over typical RH functions, including gesture recognition, verbal memory, color recognition, and the recognition of nonverbal stimuli.

Conclusion
As clinicians in the field of speech-language pathology, decisions regarding intervention methods are dependent upon the clinical expertise and external evidence found in the literature. In order to provide high-quality and individual based services, knowledge of the way in which communication breakdowns manifest is crucial. However, in rare cases such as PG's where the literature is lacking, single-subject designs are beneficial in creating a foundation of knowledge from individual patient analyses. Owing to the rare occurrence of atypical language lateralization, the findings obtained during this study have direct applications to the clinical understanding of how the brain executes language in these individuals. Furthermore, the implications of this research are influential towards the future expansion of intervention methods in the domain of aphasia and related disorders. Although further research on the right hemisphere's function following this type of language deficit is necessary, these findings will help to build a foundation in the literature as well as in the field of speech-language pathology.

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About the Author

Emily Manton is a senior double majoring in Communication Disorders and English. Her research project was completed in the summer of 2014 under the mentorship of Dr. Suzanne Miller (Communication Disorders) and made possible with funding provided by an Adrian Tinsley Program summer research grant. Emily presented this paper at the National Conference on Undergraduate Research in 2015. She plans to pursue her M.A. in speech-language pathology in the fall of 2015.

OneFund: The Illusion of One Disaster

Sarah McGuire

Every day in this country, hundreds of people are victims of violence, and many are seriously injured or killed. Disaster funds are often created to compensate victims or their families for the injuries, property destruction, and/or death caused by traumatic incidents—not only after natural disasters such as Hurricane Katrina, but also after some horrific, well publicized acts of violence perpetrated by people, such as the Boston Marathon bombing. Unfortunately, for most people injured or killed outside of such well known, specific circumstances, there is no easy or well funded avenue for compensation. There exist, then, two classes of victims, based upon the way they were injured or killed: in notorious events or lesser known incidents. This paper examines the creation of the OneFund after the Boston Marathon bombing as an example of how disaster funds work and offers alternatives that may serve all victims in an equitable manner.

After the tragedy of the Boston Marathon bombing on April 15, 2013, Boston Mayor Tom Menino and Massachusetts Governor Deval Patrick created the OneFund in order to provide victims and their families with financial compensation. The money was intended to offset expensive medical bills for the injured and to pay for funerals for those killed in the attack. The fund raised more than $60 million through contributions from both private individuals and companies ("Thank You" 2013). The next step was to distribute the collected funds. Attorney Ken Feinburg was given the difficult task of distributing the donations in such a way as would be deemed fair. To accomplish the distribution, Feinburg established a triage system that prioritized recipients based on the severity of the casualties. The first strata of victims included the families of the four people who were killed, double amputees, and those afflicted with serious brain damage. The second grouping comprised of single amputees. Those who were hospitalized made up the third group. Finally, those who received only outpatient treatment were eligible for the lowest level of compensation ("Managing the $30 Million" 2013). This hierarchy within the fund allows those more gravely injured to receive greater amounts of monetary support. It does not differentiate between victims within the same grouping, which was intentional on Feinburg's part ("Managing the $30 Million" 2013). For example, according to Feinburg, the families of both the young boy and the police officer who were killed would receive equal compensation, regardless of wage-earning status, because "when it comes to lost loved ones, all lives are equal" ("Managing the $30 Million" 2013). For the victims' families, that decision establishes that all deaths are equally significant and equally tragic.

While Feinberg's approach is perhaps the most fair and the most easily accepted by OneFund recipients, it potentially poses issues regarding the individual circumstances and needs of the victims and their families. Although it is indisputable that the lives of the boy and police officer are equally significant, it is also undeniable that the police officer's family experienced a greater financial burden with the loss of a significant wage earner. The situation could easily be remedied if the board had taken the time to examine each individual's situation and paid according to family need rather than distributing equal payments to all members of the same group. The difficulties with an individualized approach are that it would be much more time consuming and may result in complaints from those who would receive smaller payments. The individualized approach could be viewed as a signal that some lives are more significant than others, an error that Feinburg wished to avoid.

The OneFund also has the inherent limitation that it is for a specific disaster. While it addresses the fact that some of those physically injured endured much more than others and allows all victims to apply, the fund will only compensate those who were directly injured or whose family member was killed by the occurrences at the Boston Marathon. Other victims of violent crime in Boston and the surrounding area do not receive compensation simply because their circumstances did not have as high a profile. That fact—that families of those murdered during the marathon bombing will receive compensation while the families of murder victims in other parts of the city will not—ties into Noam Chomsky's debate regarding victim worthiness.

Noam Chomsky, a noted social and political critic, described the differences between "worthy" and "unworthy" victims in Manufacturing Consent (Lendman 2007). "Worthy" victims are those who receive positive media attention and a sympathetic response from the public. They are usually white, affluent or middle class, and live in the suburbs. Conversely, "unworthy" victims are often ignored or even blamed by the media and the public. They are typically poor, part of a minority group, and live in inner cities (Lendman 2007). These two groups are compensated very differently for their victimization.

In circumstances regarding donation collection, victim worthiness comes into play. Funds are created for certain "worthy" tragedies, but not for others. The OneFund was created for the victims of the Boston bombing, not for victims of other crimes that occurred, even in the same city in the same week. The OneFund compensated the families of the three people who were killed in the blast and the police officer allegedly killed by the Tsarnaev brothers a few days later. Conversely, the family of Clifton Townsend, who was shot and killed two days following the Boston bombings, will not receive compensation (Rocheleau 2013). Townsend was a 22-year-old man with an infant daughter and many friends, according to the single, short article that marked his passing (Roucheleau 2013). He was found by the police with multiple gunshot wounds, his killer unknown (Rocheleau 2013). The situation surrounding Townsend's death promotes a sense of the distinction between worthy and unworthy victims.

The worthy are those victims of the Boston bombings while Clifton Townsend is an unworthy victim. Internet searches return pages of information about the Boston bombings, demonstrating the media's focus on "worthy victims." Articles first detailed speculations about the situation. They were followed by exhaustive analysis of potential motives and continue currently with updates on the ongoing arraignment and trial of Dzhokhar Tsarnaev.

In contrast, the murder of Clifton Townsend occasioned only a single statement on a Boston website chronicling crimes in the city and a few sentences on a funeral home website. No details or speculations were raised regarding the identity of his unknown killer. Stories of his personality, childhood, or the family he left behind were not recounted. This is a gross oversight. As Ken Feinburg of the Boston OneFund stressed, "when it comes to lost loved ones, all lives are equal" ("Managing the $30 Million" 2013). Townsend's family, however, will not receive compensation for their loss or funds to assist in the burial. Instead, they are ignored by a public that never heard their story. They are the quintessential unworthy victims.

The story of Clifton Townsend raises important issues regarding the welfare and equality of all victims. Although his murder is just as tragic and as devastating to his family as those of the Boston bombing, as well as other, more highly publicized murders, because of his status as an unworthy victim he has not been elevated to heroics. Worthy victims become instant celebrities with well publicized pictures. Their life stories are broadcast from multiple news stations in order to generate public sympathy and encourage donations.

In this way, the community shares in the victimization of the crime and pulls together to address the cause. The victims are joined by the community in their effort to recover and move forward. Foundations are started to assist future victims, and families and lawmakers lobby for legislation in order to prevent further victimization.

Another common example of "worthy" and "unworthy" victimhood is in cases of child molestation and other violence against children. White, upper- and middle-class child victims are the focus of media attention and resulting legislative action, while crimes against low-income children of color rarely make headlines. Seven-year-old Megan Kanka was such a worthy victim that legislation was passed and a foundation was created in her name. Following Megan Kanka's rape and murder, Megan's Law was signed into law in 1994 in New Jersey. The legislation was promoted by her parents who gained the necessary signatures to bring the law to a vote. The entire community rallied around Megan's cause, and their actions helped to ensure that other children would be better protected. Megan's parents also founded the Megan Nicole Kanka Foundation to lobby for a federal version of Megan's Law, which was passed in 1996 ("Megan's Law" n. d.). The circumstances of Megan Kanka's life and death were highly publicized and she became a poster child for the need to change legislation. Her parents became advocates for the cause and both founded a group to assist future victims; they were instrumental in forcing new legislation to address the issue of child sexual abuse. Unfortunately, this happens in only a small subset of cases in which the victim is denoted as worthy by the media. Only when the case becomes highly publicized does the entire community come together to support the victim's family and enact change.

After Clinton Townsend's murder, no foundation was created, no new legislation was created, and no media publicity was provided. There is substantial inequality in the way victims of crime are perceived first in the media and consequently in public opinion. If Townsend had been regarded as a worthy victim by the media and had his story broadcast, perhaps his killer would have been found and brought to justice. Ken Feinburg's statement about the worthiness of all victims should apply in all criminal situations to reflect the equal worth of all human beings.

The Victims of Crime Act (VOCA) is one imperfect, and little known, solution that already exists. Established in 1984 to provide victims with compensation for medical expenses, mental health counseling, burial and funeral costs, as well as loss of wages and support ("Victims of Crime Act" 1999), the fund seeks to provide a broader base of victims with assistance and

compensation. To apply for assistance, victims must report the crime to law enforcement within three days and file a request for compensation within three years ("Victims of Crime Act" 1999). Unlike the OneFund, it does not make designated payments to all victims in a similar grouping. Instead, it takes into account private insurance coverage and seeks to pay only what insurance will not cover. In this way, VOCA funding is individualized and personalized in ways that the OneFund is not. It is also need-based, ensuring that victims do not profit from their misfortune, but are instead compensated for their loss.

Because of its application requirements and limited financial resources, VOCA funding is not the final solution to the problem. As mentioned earlier, in order to apply for aid, a victim must report the crime to the authorities within three days of the offense ("Victims of Crime Act Crime Victims' Fund" 1999). This may make sense because it allows the VOCA committee to validate the occurrence of the crime but it excludes victims of frequently underreported crimes such as sexual assault, domestic violence, and child abuse. Such victims may be still able to seek help from other organizations, but they will not be eligible to receive financial compensation.

The application process requires the use of a computer to download the appropriate forms, requiring some technological knowledge as well as computer and internet access. While it may be argued that computer access is available at public libraries, the fact still stands that many will be unprepared to navigate the complicated site and locate the appropriate forms. In this way, the VOCA compensation still favors better educated, wealthier victims and is less likely to aid the poor victims who desperately need help.

Finally, as with all funds, VOCA has limited financial resources and cannot adequately compensate every crime victim. Recent changes now allow donations by private individuals to supplement the money received from criminal fines, forfeited bail, penalties, and assessments made by the U. S. Attorneys' offices, the U. S. Federal Courts, and the Federal Bureau of Prisons ("The Crime Victims' Fund" 2010). This expanded financial pool has aided in the growth of resources available, but still does not provide compensation for every victim. Although not perfect, VOCA funding demonstrates a positive step in recognizing the equality of all crime victims.

While the Boston OneFund and other specific disaster funds are formed with the best intentions and seek to restore the victims of a given crisis, they fail to address those affected by other, lesser known tragedies. These special compensation funds, alongside media portrayals, create and promote versions of "worthy" and "unworthy" victims. Worthy victims receive publicity and assistance while unworthy victims are largely ignored. In effect, a special fund creates the illusion that there is only one tragedy.

In direct contrast to these well intentioned but flawed disaster funds stand programs such as the Victims of Crime Act funding, which provides a wider range of compensation to many victims of all crimes. While not perfect because of application requirements and resource limitations, VOCA recognizes both the equal worthiness of victims of varying crimes as well as individual financial circumstances. This allows VOCA to distribute funds according to need and severity of injury rather than happenstance.

In looking for an answer to the question of the effectiveness and equality of disaster programs, it would be much more beneficial to all victims for individual disaster funds to cease collecting for specific disasters. The public and the fundraisers could then combine efforts with VOCA, by campaigning to raise money for specific disaster victims and others who have suffered similar effects, and donate the money to VOCA for distribution. This compromise would improve publicity and funding for VOCA while enabling individual victims and their families to continue their empowering lobbying for their cause. It might also encourage Feinburg and others involved in specific disaster funds to channel their efforts into helping all victims. VOCA and similar funds would end the discrimination inherent in special disaster funds and the limited funding that VOCA suffers. In the end, we could abolish the perception of certain victims as unworthy and focus in a unified effort on the prevention of future tragedies.

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About the Author

Sarah McGuire wrote this piece for Dr. Richard Wright's (Criminal Justice)Honors Introduction to Criminal Justice course.

Influence of Traditional and Nontraditional Entries on Figure Skating Jumps

Bryanna Nevius

Introduction

Jumping is one of the first basic movements that one learns to perform as a child. The skill is mastered fairly quickly and as the child grows, it often becomes a valuable skill in many of the sports they participate in. Gymnastics, track and field, and figure skating are a few of the sports where jumping is not only a valuable skill, but also a required one. The United States Figure Skating Association states that three of the required elements in the ladies short program must be jump elements, and allows a maximum of seven jumps in the ladies long program (USFSA, 2013). The quantity of jumps equals more than half of the elements in both the ladies short and long programs. As jumping is such an important factor in the sport, a great deal of emphasis is placed on the skater's performance of jump elements. Over the years, judges have also started to reward skaters for making a traditional jump more difficult. In other words, skaters will receive more points for a jump with a difficult entry than they would receive for the same jump with a traditional entry.

With the creative freedom that skaters have in terms of their jump entries and with the extra points as incentive, more often than not, a skater will perform a more difficult version of a traditional jump by varying the entry. However, this trend may become a cause for concern if skaters are not proficient at their non-traditional jump entries, yet include them in the program in hopes of earning extra points. This begs the question of whether or not it is worth the extra points to include a non-traditional jump entry if the skater is more skilled at performing the same jump with a traditional entry.

The first jump examined in this study was the salchow. At its most basic level, it is characterized by its takeoff position, which is a backward inside edge. Once the skater is in the air, they complete one full rotation. With skill development the skater adds more rotations to complete jumps such as the double salchow, the triple salchow, and the quadruple salchow (Figure 1).

The toe loop is the second jump analyzed in this research study, and it is a toe jump as is stated in the name. The toe loop first
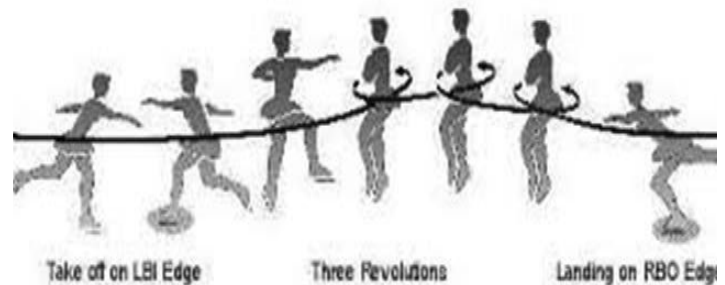
Figure 1: The Triple Salchow [iceskate.net]
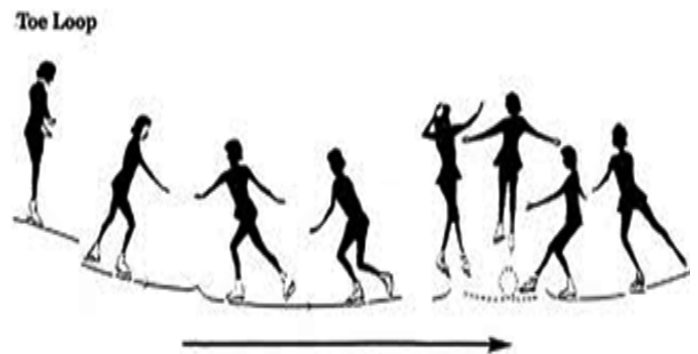
Figure 2: The Single Toe-Loop [Martinez, C.]

takes off on two feet before it requires one foot. Essentially there is a transfer of weight that occurs from the back outside edge to the extended leg. As the skater glides on the backward outside edge, their weight is gradually transferred from that leg to the extended free leg with the toe pick in the ice. The skater will take off from the extended free leg with the toe pick in the ice, which differentiates this jump from the axel and the salchow (Figure 2).

Methods

Subjects: Ten female figure skaters from Massachusetts and Rhode Island volunteered for this study. All were able to perform both double salchows and double toe loops proficiently from both traditional take offs and a non-traditional take-off of their choice. The participants were chosen through communication with coaches and parents. Before data collection began, all participants, as well as the parents of participants under 18-years-old, were asked to sign a Bridgewater State University approved consent form stating that they agreed to be participants in this study.

Procedure

The data for this research were collected on three separate days in different locations, with different skaters. The same procedures were followed each day; however, the number of skaters filmed during each session differed. Ten skaters in total participated in the research study. Five skaters were filmed on the first day of data collection. Skaters arrived at the rink at approximately

8:15 am and filled out a Bridgewater State University approved consent form as well as a demographic survey. After the paperwork was completed, the skaters, under my direction, placed joint markers on both sides of their legs at their hip, knee and ankle joints. At 8:50

Figure 4: Take-off Angles [Wikibooks.org]

am the skaters took the ice and they had 20 minutes to warm up before the filming began. During this time, I set up the necessary equipment, which included two tripods and two cameras. One camera was placed in the hockey box and one was placed on the ice near the Zamboni® door. After the cameras were placed, a subject performed a double salchow and a double toe loop in front of the cameras to confirm the accuracy of the camera's field of view. The subject also demonstrated to the others where to perform their jumps in relation to the camera. After the locations were confirmed, filming began and all five skaters performed five trials of the jump they had chosen (double salchow or double toe loop) with a traditional entry. Once the trials were completed, the skaters repeated five times with a non-traditional entry. During the filming of all the non-traditional entries, a third camera was used to capture the entire entry and take-off position. On the second day of filming a very similar procedure was followed; however, only one subject was filmed. The third day of filming was procedurally similar to the first and second days. Four skaters were filmed performing the jump of their choice for five trials with both traditional and non-traditional take-offs, and a third camera was used in these non-traditional trials as well.

Data Collection and Analysis
During the study a standard video-tape camera (Cannon digital camera ZR960), as well as two digital cameras (Nikon Cool Pix S6100 and Sony Cybershot DSC-S750), were used to collect data from the skaters during their practice sessions. Once all of the data were collected, it was uploaded to the computer with DartFish software, and further analyzed. Using DartFish, each of the skater's trials, both traditional and non-traditional, were analyzed specifically in terms of the take-off angle of the ankle, knee, and hip joints (Figure 3), the maximum jump height, airtime, horizontal displacement, and the landing angle of the ankle, knee, and hip joints (Figure 4).

Figure 5: Landing Angles [Oocities.org]

Take-off positions for the toe loop were defined as the last backward movement when both feet were still in contact with the ice and the take-off position for the salchow was defined as the last backward movement when the full blade was in contact with the ice. Jump height was found by measuring the highest point the skater reached in the air to the ice surface and subtracting her height from that value; horizontal displacement was defined as the distance from the moment the skater's blade left the ice at take off to the moment the toe-pick first made contact with the ice at landing. Airtime was defined as the time between the take-off position and the landing position, approximating the moment the skater's blade left the ice to when it first landed on the ice again.

Data were then analyzed with DartFish ProSuite V 6.0 and entered into Excel 2008. A series of paired samples t-tests compared the ankle, knee and hip angles at take-off and at landing, maximum jump height, airtime, and horizontal displacement between traditional and non-traditional entries. Entries for all jumps, just toe loops, and just salchows were compared and the significance level of .05 was adjusted using a Bonferonni correction. In total there were one hundred trials analyzed (ten trials per skater); however, some trials that were videotaped were excluded because of falls or step outs, leaving 43 trials for analysis.

Results
Subjects: The subjects, whose data can be seen in Table 1, consisted of ten female figure skaters who were able to perform either a double salchow or a double toe loop from both a traditional entry and a non-traditional entry of their choice.

Table 1 Subject Demographics

	Age (yrs)	Height (m)	Weight (N)	Skating Experience	Hours/ Week
Mean	15	1.5	447.0	10.2	6.6
Standard Deviation	3.7	0.09	90.02	3.6	3.9

The subjects volunteered to participate in the study and they signed an informed consent form stating this agreement. Of

Table 2. Comparison of Traditional (T) with Non-Traditional (NT) Take-off Angles

Jump	Ankle T	Ankle NT	Knee T	Knee NT	Hip T	Hip NT
Toe Loop	83.6±10.6	86.6±8.9	126.6±18.1	128.8±19.2	127.8±21.1	135.5±28.6
Salchow	79.8±12.0	82.5±6.1	125.9±5.8	122.7±7.83	126.9±8.1	129.2±13.5
All Jumps	81.8±11.3	84.5±7.8	126.3±13.6	125.7±14.7	127.4±16.1	132.3±22.1

Note: all measures in degrees; Traditional=T; Non-Traditional=NT Bonferroni Correction p=<.005

Table 3. Comparison of Flight: Traditional (T) versus Non-Traditional (NT) Entries

Jump Type	Max Jump Height T (m)	Max Jump Height NT (m)	Airtime T (s)	Airtime NT (s)	Horizontal displacement T (m)	Horizontal displacement NT (m)
Toe Loop	0.33±.13*	.46±.171*	.62±.07	.63±.11	1.31±.53	1.04±.17
Salchow	.38±.14	.43±.117	.78±.12	.77±.09	1.56±.64*	1.83±.72*
All Jumps	.36±.14*	.44±.145*	.69±.12	.70±.12	1.43±.59	1.45±.66

Note: *= Significant difference at p= <.005

the ten skaters, one was at the pre-juvenile level, three were at the juvenile level, three were at the intermediate level, one had passed novice, and two were seniors. Nearly all of the subjects practiced all jumps from traditional entries (eight subjects), one subject practiced axel, double salchow, double flip and double lutz with traditional entries, and one subject practiced axel, double salchow, double toe loop, and double loop from traditional entries. In terms of jump performance with non-traditional take off positions, three skaters performed the axel, five skaters performed a double salchow, six skaters performed a double toe loop, four performed double loops, five performed double flips, and three performed double lutzs. In the demographic survey skaters were asked when they felt comfortable practicing either the double salchow or double toe loop with a non-traditional take-off position. Six skaters said when they were consistent with landing the jump, two skaters responded always, one skater said one year prior, and one skater responded when she tested up to the level prior to her current placement.

Take-off Angles
The results of the jump take-off measurements analyzed with Dartfish are presented in Table 2. In overall jumps and in the toe loop and salchow, there were no significant differences between traditional and non-traditional entry take-off angles for the ankle, knee, or hip. There were, however, almost significant findings for the ankle and hip joints at takeoff. For the angle of the ankle at take-off the mean was 81.8 ± 11.3 degrees for traditional trials and 84.5 ± 7.8 degrees for non-traditional trials (p = .023); this shows slightly more plantar flexion in non-traditional trials. The hip joint angles at take-off for traditional trials were 127.4 ± 16.1 degrees and 132.3 ± 22.1 degrees or non-traditional trials (p = .028). This shows

slightly more hip extension during non-traditional trials.

Flight
The results of the flight time measurements analyzed with Dartfish are presented in Table 3. In all jumps, the only significant difference during flight was the maximum jump height. The mean for the traditional jumps was .36 ± .14 m while the non-traditional mean was .44 m ± .15 m (p = .001). There was a significant difference in jump height, in the toe loop particularly, where the mean for the traditional toe loop was .33 ± .13 m while the nontraditional mean was .45 ± .17 m (p = .0005). In the salchow, there was only a significant difference in the horizontal displacement of the jumps. The traditional salchow mean was 1.56 m ± .64 m while the non-traditional salchow had a mean of 1.83 m ± .72 m (p = .001).

Landing Angles
The results of landing angles analyzed with Dartfish are presented in Table 4. There were significant differences for the ankle angle at landing in all jumps where the mean for traditional trials was 85.7 ± 12.9 degrees and the mean for non-traditional trials was 90.5 ± 8.6 degrees (p = .001). There were also significant differences found for the angle at the ankle joint toe loop jumps, where for traditional trials the mean was 83.9 ± 12.5 degrees and the non-traditional mean was 88.7 ± 9.12 degrees (p=.001). This shows greater plantar flexion during non-traditional trials at landing versus traditional trials at landing.

Discussion
The purpose of this study was to determine whether or not adding a non-traditional jump entry into a routine is beneficial to the skater or if there is more value in performing the same

Table 4. Comparison of Traditional (T) with Non-Traditional (NT) Landing Angles

Jump	Ankle T	Ankle NT	Knee T	Knee NT	Hip T	Hip NT
Toe Loop	83.9±12.5*	88.7±9.1*	135.1±6.3	135.8±7.9	129.5±14.4	136.1±14.7
Salchow	87.5±13.2	92.2±7.9	134.6±8.7	129.3±9.5	128.2±19.6	133.4±15.2
All Jumps	85.6±12.9*	90.5±8.6*	134.8±7.4	132.5±9.2	128.9±16.9	134.7±14.8

Note: All measures in degrees; Traditional=T Non-Traditional=NT*= Significant difference at p=<.005

jump with a traditional entry. Biomechanical effectiveness was examined by measuring the angles of joints at takeoff and landing, as well as measuring jump height, horizontal displacement, and flight time. It was hypothesized that non-traditional entries would change jump kinematics when compared to the same jumps performed from traditional entries.

Take-off Position

There were no significant differences found during the take-off portion of the jump for traditional and non-traditional jump entries. However, there were almost significant findings for the angle of the ankle at take-off, indicating more plantar flexion in non-traditional trials. This may indicate that during traditional take-off positions the skater has more time than in non-traditional trials to dorsiflex the ankle joints to prepare for the jump. Studies have shown that knee and other joint patterns contribute to a successful completion of the jump, and more successful landings (Johnson & King 2001), suggesting that the decrease in plantar flexion of the ankle joint in traditional jumps might allow for a more successful completion of that jump. It could also suggest that the skater is further along, timing wise, in their jump during non-traditional trials (i.e. the dorsiflexion of the ankle may be complete and is now plantar flexing).

During non-traditional trials of all jumps, there were also almost significant findings for the hip joint angle at take-off where there was more hip extension as compared to traditional trials. This hip extension during non-traditional trials of all of the jumps may indicate that the skater is able to flex the hip joint more during traditional trials. Like the ankle findings, more hip joint extension during non-traditional trials at take-off could also suggest that the skater has already flexed the hip and is now extending it. The hip flexion in traditional jumps may be a result of traditional constraints in terms of technique placed on the skater while performing the traditional entry. This change in the hip take-off angle could influence the landing.

Flight

When toe loop and salchow jump trials were combined, there were significant findings during flight as well. Maximum jump height was greater for non-traditional trials of all jumps when compared to traditional trials of all jumps. These findings indicate that greater jump height may be a by-product of performing jumps with a more difficult take-off position.

There were significant findings during flight, particularly in the toe loop. There was a significant difference in jump height as the non-traditional trials were higher than the traditional entry trials. There were also significant findings in the salchow trials as well; the non-traditional horizontal entry provided for greater displacement than the traditional entry.

The significant findings for jump height during all jumps are most likely influenced by the significant findings for maximum jump height during toe-loop trials. Both the toe loop trials and the all jump findings show significant differences in maximum jump height. This could suggest a relationship between jump height and the technique associated with the toe loop jumps, especially during non-traditional trials. To perform a toe loop from both a traditional and a non-traditional take-off position, the skater applies most of their weight on their favored leg and places the toe-pick of their free leg into the ice, which helps to propel them into the air. This movement essentially slows the horizontal portion of the jump in order to increase the vertical movement of the jump, which could cause the increased jump height in the toe-loop verses the salchow. The increased jump height in the toe loop during non-traditional entries could be related to a lack of the technical limitations associated with the traditional take-off position.

The significant findings in the salchow trials for horizontal displacement were also likely caused by the jump's specific technique. The salchow is an edge jump, meaning that the toe-pick is not utilized at all during take-off, which allows for more horizontal movement versus jumps that utilize the toe pick, such as the toe loop. Due to this variation in jumping technique, the horizontal speed of the salchow was not decreased as it was in toe loop trials, perhaps allowing for an increase in horizontal displacement with a non-traditional entry. Non-traditional entries may be more effective at creating a greater horizontal distance for edge jumps.

Landing Position
During the landing portion of the jump, there were significant differences in all jumps for the ankle angle, which showed greater plantar flexion during nontraditional entries when compared to traditional entries. There were also significant differences for the angle of the ankle joint during toe loop trials, which also showed greater plantar flexion at landing from non-traditional entries compared to traditional entries.

The increased plantar flexion at the ankle in all jumps during non-traditional trials is most likely due to the increased plantar flexion in the toe loop. This may indicate that the significant difference in the angle of the ankle during the toe loop and all jumps may be caused by the significant height difference found in the toe loop and all jumps. These two jump characteristics may be related to each other, suggesting that the increased height during non-traditional trials may allow for the ankle to plantar flex in an effort to stabilize the landing portion of the jump. In addition to the jump height, jump timing may also be related to the increased plantar flexion. The non-traditional jumps seem to have a less structured technique throughout the jump because they do not have to start with a specific take-off position as traditional jumps must. This may permit the jump to attain a larger maximum height, and consequently greater plantar flexion at the landing.

Summary and Recommendations
The purpose of this study was to determine whether or not adding a non-traditional jump entry into a routine is beneficial to the skater or if there is more value in performing the same jump with a traditional entry. In order to earn more points during competition, many skaters and their coaches implement non-traditional take-off positions and in increased difficulty into the jump. The opportunity to earn extra points is appealing when as little as one tenth of a point can define how well an athlete performs. However, it was hypothesized that non-traditional entries would change jump kinematics when compared to the same jumps performed from traditional entries.

Significant differences were found in all jumps for jump height, horizontal displacement and the angle of the ankle during landing, with nontraditional trials greater for all three aspects of the jump. Differences were expected between traditional versus non-traditional versions of the same jumps, however these specific differences were not anticipated. While unanticipated, the differences highlight the fact that non-traditional jump entries do cause differences in the jump when compared to the traditional entry of the same jump. Increased plantar flexion during the landing is most likely caused by the increase in jump height during non-traditional trials. This

increase in jump height may cause more difficulties in terms of the amount of control the skater has over the jump verses the amount of control they have over the traditional version. Increased horizontal displacement during non-traditional trials may have the same effect.

These particular findings do seem to support the hypothesis; nontraditional jump entries did cause a change in the jump kinematics when compared to traditional entries of the same jumps. Almost significant findings were seen during take-off when measuring the angle of the ankle and hip. The angles of both hip and ankle increased almost significantly during the take-off portion of non-traditional trials. This suggests that during traditional trials, skaters had more confined take-off positions; their hip and knee joints were flexed more, allowing them to prepare for the jump differently as compared to non-traditional trials.

The findings of this study could be further supported through a larger sample size as well as the acquisition of jump scores from an accredited figure skating judge. This would allow further insight into which jump take-off is more effective at earning more points from the perspective of the skater and the coach. In addition to the previous improvements, future research should be directed towards studying different aspects of jump difficulty other than take-off positions to gain a better understanding of traditional versus non-traditional jumps as a whole.

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About the Author

Bryanna Nevius is a graduating senior majoring in Physical Education, with a concentration in Exercise Science, and minoring in Management. In the spring of 2014, she received an ATP research grant which allowed her to complete her honors thesis under the guidance of her mentor, Dr. Pamela J Russell (Movement Arts, Health Promotion & Leisure Studies). She plans on pursuing a career in Sports Medicine following the completion of her undergraduate work in the spring of 2015.

Divining Very: Reconciling Christian and Transcendentalist Philosophies in the Poetry of Jones Very

KIRSTEN RIDLEN

On July 15, 1838, Ralph Waldo Emerson gave his address to the graduating class of Harvard's Divinity School. In it he boldly criticized the state of organized religion before a class of newly-minted religious leaders, and he impressed upon them a duty to reform churches that had fallen into comfortable routine, abandoning the pursuit of truth in favor of dated tradition. In effect, he called for the total reconstruction of religion as they knew it.

Though it was audacious of Emerson to suggest to a crowd of Harvard graduates that they should now begin to reconsider everything they had been taught--finding, as he did, religious culture in dire need of reform, and maintaining the pursuit of Truth as his primary goal—he believed that radical action was necessary. "Historical Christianity," Emerson says in his address, "has fallen into the error that corrupts all attempts to communicate religion." He explains, "As it appears to us, and as it has appeared for ages, it is not the doctrine of the soul, but an exaggeration of the personal, the positive, the ritual. It has dwelt, it dwells, with noxious exaggeration about the person of Jesus" (Emerson 236). This is Emerson's primary criticism: that religious truth is compromised by Church rituals, which have been diluted by the tedium of going-through-the-motions, whose original meaning and intent has been lost to the ages. And yet worshippers come to rely on those rituals, as if in going through the motion they forget the spontaneity and sincerity of prayer. So the rituals that served as an intermediary between the soul and the Spirit have superseded their purpose and become the very root of worship. From this reliance on tradition--on what Emerson calls "historical Christianity," which is founded on scripture stories rather than the divinity Emerson believed to be inherent in every person--comes this "noxious exaggeration of the person of Jesus," whom Emerson believed to be a prophet, but not the God that Christians considered him to be. Rather than looking to Jesus as a true spirit of inspired faith, religion became dependent on him, for all intents and purposes, as a storybook character.

"Christianity," as Emerson writes, "became a Mythos as [did] the poetic teaching of Greece and of Egypt, before" (Emerson 235). Of this subjugation of the individual to a singular deity, Emerson says,

> Once man was all; now he is an appendage, a nuisance. And because the indwelling Supreme Spirit cannot wholly be got rid of, the doctrine of it suffers this perversion, that the divine nature is attributed to one or two persons, and denied to all the rest, and denied with fury. The doctrine of inspiration is lost; the base doctrine of the majority of voices usurps the place of the doctrine of the soul. Miracles, prophecy, poetry, the ideal of life, the holy life, exist as ancient history merely; they are not in the belief, nor in the aspiration of society; but, when suggested, seem ridiculous. Life is comic or pitiful, as soon as the high ends of being fade out of sight, and man becomes near-sighted, and can only attend to what addresses the senses (Emerson 234-235).

Religion has effectively degraded the true spirituality of man, usurped the power of the individual--his divine inspiration and sanctity of his soul--in order to bestow that authority on one ethereal God. Here, Emerson establishes his--and generally the Transcendentalist--theory of spirituality: that divinity comes from within each person. He condemns religion as an institution much like any business or politic that likewise has corrupted the humanity of his society. Among the Transcendentalist community that Emerson founded and helped cultivate, religion was a primary target for reform.

Sitting in the audience for Emerson's "Divinity School Address" was a young poet named Jones Very. That address was not their first encounter, as Very had visited the Concord compound on April 4 of that year (just three months earlier); nor was it their last. Many critics have wondered how a man as religiously fervent as Jones Very became affiliated with the Transcendentalist Movement.

Jones Very was born on August 28, 1813 in Salem, Massachusetts. As his father died when he was just 11, he was raised mostly by his mother--an atheist whom Robert D. Richardson, Jr. describes in his book, Emerson: The Mind on Fire, as "a forceful, outspoken materialist" and "a disciple of Frances Wright" (302), so Very's aptitude for social reform, at least, was in his blood. But he did not become much involved with religion until he began his studies at Harvard in 1834, and there he spiraled straight into zealotry.

Richardson describes Very's stern countenance:

His 'tall angular figure' moved with a long, stately stride. His manner was solemn and fervent. His skin was stretched tightly over his face, which was thin and smooth with a high forehead. He wore a large black hat, a black suit and frock coat, and he carried a black walking stick. A photograph shows his small rigid mouth set in a straight line, his eyes locked in a stare and fixed on a spot just past the viewer's left ear. (302)

He was like something out of Hawthorne's Black Veil, and he was received with as much hesitation. Richardson notes that he was "The oddest, most compelling, and most trying of the new acquaintances" in Emerson's camp. Very had taken Emerson's "Address" very much to heart and now believed himself, "apparently literally--to be the 'new born bard of the Holy Ghost' Emerson had called for" (301).

By 1838, Very was at the height of his religious fervor. Having been fired from his position at Harvard as a Greek tutor for going off-syllabus and encouraging his students to "flee to the mountains, for the end of all things is at hand," like a prophetic doomsday prepper, he visited Elizabeth Peabody (on September 16, 1838), who recalled the encounter:

> One morning I answered a ring at the door and Mr. Very walked in. He looked much flushed and his eyes very brilliant and unwinking. It struck me at once that there was something unnatural--and dangerousness in his air--As soon as we were within the parlor door he laid his hand on my head--and said "I come to baptize you with the Holy Ghost and with fire"--And then he prayed. I cannot remember his words, but they were thrilling--and as I stood under his hand, I trembled to the center. (Richardson 303)

Very continued to baptize several Salem ministers, leading to his prompt commitment to McLean's Asylum for a month. He was released on October 17 of that year, considerably more moderate thereafter (Richardson 304).

Very's fanatic behavior unsettled his Concord peers. Richardson suggests that Emerson's words fueled Very's belief in his own superlative divinity, and that "as a result he considered himself to be literally a vehicle for the Holy Ghost, to be the only such vehicle, and at the same time to be--personally--the second coming, the Messiah" (303). In this sense, Very seems to have missed the mark entirely.

The Transcendentalist movement was one founded on the principles of institutional reform. Naturally the focus on reform created tension between the movement and the institutions it targeted. Chief among them were the rigid religious sects that had abandoned what Transcendentalists believed to be their true purpose in favor of empty tradition and blind faith— the sects which Very, with his fervent preachiness, seemed to represent. Growing Western interest in science and the will to question led the Transcendentalist movement's founders and followers to doubt religion, especially when it relied upon weak spiritual foundations. The Transcendentalist school of thought was set immediately at odds with religious sects that had fallen into a comfortable, though indefensible, routine.

In his article, "Nature as Concept and Technique in the Poetry of Jones Very," Anthony Herbold identifies a seeming blatant contradiction in the poetry of Jones Very: It is at once deeply reverent and undeniably Christian, and at the same time devoted to nature in a secular way, without any apparent conversation between the two. Herbold argues that this tension is evidence of a multiplicity in Very--that there were at least two identities, a wholly secular and a wholly sacred Very, and never was one cognizant of the other.

Herbold argues that there are two major forces of influence acting on Very's poetic voice, even creating, as Herbold suggests, "several Verys," distinct from one another and acting independently, such that one can discern precisely which state of "Very" the poet was in when he wrote each particular poem. Herbold even goes so far as to suggest that each voice acts autonomously, each one so contrary to the other that, "all the while Very the poet seems unaware of these disagreements." Herbold calls him "the will-less stenographer of the Spirit," as if he had no control over which of these two voices might erupt from his pen--each poem being just that incompatible with the next (244).

The first of these voices Herbold identifies as the Christian within Very. This voice typifies nature as "finite, contingent, imperfect [and] a poor teacher" (245). This Very regarded nature with a lower-case n, beloved as the creation of God, but insubstantial on its own. Herbold cites Very's "The Garden":

> I saw the spot where our first parents dwelt;
> And yet it wore to me no face of change,
> For while among its fields and groves I felt
> Is if I had not sinned, nor thought it strange;
> My eye seemed but a part of every sight,
> My ear heard music in each sound that rose,
> Each sense forever found a new delight,
> Such as the spirit's vision only knows;
> Each act some new and ever-varying joy
> Did by my Father's love for me prepare;
> To dress the spot my ever fresh employ,

And in the glorious whole with Him to share;
No more without the flaming gate to stray,No
more for sin's dark stain the debt of death's to pay.
(Very 291)

Herbold suggests that "Very, himself a disciple, wanted only 'the spirit's vision,'" disavowing the senses, for "he believed not only that the sense perceptions give rise to an inferior sort of poetry … but that unless we stop up the senses we shall not perceive the Unseen," which is exclusively where Christian Very believed spirituality existed (249). The speaker of this poem delights in the scene before him, but physically there is nothing remarkable about this particular encounter: "I saw the spot where our first parents dwelt; / And yet it wore to me no face of change." Rather, nature lends itself to poetry now because the speaker has been infused with the spirit of God: "Each act some new and ever-varying joy / Did by my Father's love for me prepare." Nature, then, according to this first incarnation of the poet, has no inherent spirituality within it, but only the meaningfulness that comes from the individual, inspired by the creation before him, placed there by the divine Will of God. This is the inverse of Emerson's belief that the source of the Spirit is within man, that "That which shows God in me, fortifies me. That which shows God out of me, makes me a wart and a wren" (Emerson 236). Yet regardless of where each man believes the origin of the Spirit lies, both agree that it rests eventually within, and thus enlightens them in kinship with nature.

The second of these voices, more in line with Very's Transcendentalist education and community culture, was, as Herbold says, "infinite, self-generating, perfect" (246). These poems are alive with all the sense and feeling of the poet, personified in the natural landscape of the poem. He refers to "Autumn Leaves," where Very at last concedes that perhaps in nature there are "the unseen hues of immortality":

> The leaves though thick are falling; one by one
> Decayed they drop from off their parent tree;
> Their work with autumn's latest day is done,
> Thou see'st them borne upon its breezes free;
> They lie strewn here and there, their many dyes
> That yesterday so caught thy passing eye;
> Soiled by the rain each leaf neglected lies,
> Upon the path where now thou hurriest by;
> Yet think thee not their beauteous tints less fair,
> Than when they hung so gaily o'er thy head;
> But rather find thee eyes, and look thee there
> Where now thy feet so heedless o'er them tread;
> And thou shalt see where wasting now they lie,
> The unseen hues of immortality. (Very 293)

There is no mention of God in this poem. The leaves exist in their own right. Nature here is an autonomous, self-generating system: "The leaves though thick are falling; one by one / Decayed they drop from off their parent tree." The Father, here, is the tree. This is a clear admission of secular sovereignty.

Herbold is uneasy with this seeming contradiction of Very's previous philosophy, and so concludes that the poet must be in the throes of a "spiritual apartheid" (244). But Herbold wrongly assumes, as many critics do, that Very must be either a Christian or a Transcendentalist. His argument assumes that there is no place for a Christian among Transcendentalists, but in fact the defining character of the Transcendentalists was not that they were atheists, but reformers. And Jones Very was, most certainly, a reformer.

His poem "The New Birth" is all about the rejection of old ideals and the conversion to a new Enlightenment:

> 'Tis a new life--thoughts move not as they did
> With slow uncertain steps across my mind,
> In thronging haste fast pressing on they bid
> The portals open to the viewless wind;
> That comes not, save when the dust is laid
> The crown of pride that gilds each mortal brow,
> And from before man's vision melting fade
> The heavens and earth--Their walls are falling now--
> Fast crowding on each thought claims utterance strong,
> Storm-lifted waves swift rushing to the shore
> On from the sea they send their shouts along,
> Back through the cave-worn rocks their thunders roar,
> And I a child of God by Christ made free
> Start from death's slumbers to eternity. (Very 290)

The opening lines signify a transition from the "slow uncertain steps" of blind faith to the "thronging haste" in pursuit of truth. What Very seems to be invoking here is the philosophical revolution that was the Transcendentalist movement. His language evokes the tempestuous nature of the moral conflict: "from before man's vision melting fade / The heavens and earth--Their walls are falling now-- / Fast crowding on each thought claims utterance strong." He does not renounce his faith, but suggests that he has been born into a new way of thinking—one that, in fact, has brought him closer to God and "by Christ made [him] free."

Herbold fails to acknowledge the fact that there can and must be some reconciliation of the voices. It is too simple for any literary critic to suggest that a worthy writer does not know exactly what he is doing with his work—that any stroke has

not been mulled over for hours in agony before meeting public scrutiny. The question, then, is not whether half of Very's poetry lends itself to the movement, but how his entire poetic approach aligns with Transcendentalist sensibility.

It was Very's essay, "Epic Poetry," that first caught the attention of the Transcendentalists in Concord. Elizabeth Peabody heard him deliver the lecture in Salem in December 1837 and encouraged Emerson to invite Very to Concord, which was the occasion of his April 4 visit the next year (Richardson 303). In his essay, Very argues that poetry has evolved simultaneously with the theology of the time. The poetry of the time when great Greek heroes ruled the world, for instance, was appropriately Epic.

Very observes that, "to men in the early stages of society their physical existence must seem almost without end, and they live on through life with as little reference to another state of being as we ourselves do in childhood." There was no study of the human condition or past implications on the future in those times, only the matters of the day. There was no emphasis on the afterlife as there is in modern Christianity, and so public interest was in external conflict: war and adventure and mischievous gods. Very suggests that, "if to these advantages possessed by Homer we add those which belonged to him from the religion of his times and from tradition, whose voice is to the poet more friendly that the plain written records of history, we must confess that the spot on which he built up his scenes of heroic wonder was peculiarly favorable" (1-2). In other words, Homer's epics were successful because his spiritual climate was especially hospitable to epic poetry.

Cultural theology later evolved into Christianity. Very argues,

> As the mind advances, a stronger sympathy with the inner man of the heart is more and more felt, and becomes more and more the characteristic of literature. In the expanded mind and cultivated affections, a new interest is awakened, dramatic poetry succeeds the epic, thus satisfying the want produced by the further development of our nature. For the interest of the epic consists in that character of greatness that in the infancy of the mind is given to physical action, and to which the progress of man the greatness of the other becomes subordinate. For as the mind expands and the moral power is developed, the mightiest conflicts are born within--outward actions lose their grandeur, except to the eye, for the soul looks upon them but as results of former battles won and lost, upon whose decision, and upon whose alone, its destiny hung. (Very 10-11)

Religion became more introspective and man's perception of conflict began to focus on the internal rather than the external. Human conflicts were no longer only conflicts of action--of war and loyalty and honor--but of morality. And so reigned the dramatic poetry of the individual, of introspection, of the almighty senses.

With this discussion of Christianity as an evolution of Greek polytheism, Very not only gives credit to Emerson's criticism of historical Christianity as a Mythos of the same kind, but also argues reasonably for Christianity as a necessary tool of the poet. In order for their work to resonate with their audience, they need to have a working understanding of popular theology, which puts Very's religious tone in a fairly defensible position. Very's attitude toward Christianity throughout the essay is entirely pragmatic. He calls it the "ideology of the time," as if religion is a hazard of modern poetry, which must always be keen to public sensibilities. This is not to suggest that Very was not sincere in his faith, but that perhaps his faith was secondary to his craft, and that far from being overcome in his writing, as Herbold suggests, it is evident in this essay that Very was most certainly conscientious and deliberate in his approach.

It is not entirely fair, either, to say only that Very was a student of Emerson. Very arrived at Concord on the recommendation of his own lecture a full three months before Emerson gave his Address at Harvard, and Very's influence on the address is obvious. Emerson states that, "the intuition of the moral sentiment is an insight of the perfection of the laws of the soul. These laws execute themselves. They are out of time, out of space, and not subject to circumstance" (Emerson 232). The lines echo Very's own statements on the moral power at the root of all internal conflict. Richardson even goes so far as to suggest that, "the example of Very was one reason why Emerson could so confidently call for a new 'teacher' and could assure his audience that they were, each and all, newborn bards of the Holy Ghost" (303), which must, in itself, be enough to stake Very's claim as a Transcendentalist.

Critics have always struggled to discern exactly what defines a Transcendentalist anyway. In his essay, "Jones Very, the Transcendentalists, and the Unitarian Tradition," David Robinson points out that "many of the problems involved in Very's link with the Transcendentalists have their basis in the amorphous, many-sided nature of the Transcendentalist movement itself." He notes that "the members of the group never claimed cohesiveness, and resisted what they felt were the confusing connotations of the term 'Transcendentalist,'" and that "the group was unified more in spirit than technical philosophy" (Robinson 104). So Very, of course, cannot be

excluded merely on the grounds that he was too pious, though the struggle to place him remains.

Robinson's analysis of Very focuses on the poet's theory of the "will-less existence": the belief that man must live in order to remain close to God (105). Believing that a man's proud will is the force that separates him from God, Very argued that by surrendering oneself to the Spirit, one could be guided to righteousness. This surrender to Spirit is what Robinson believes to be behind the conversion depicted in Very's aforementioned poem, "The New Birth." He suggests that "the 'change of heart' is also a change of mind and perception which quickens and expands former thought" (106). He also notes Very's use of nature as a metaphor for the spirit, a token Transcendentalist habit:

> Although "the heavens and earth" fade before him, he ends the poem with the extended natural metaphor of the sea, now changed externally by the storm winds which rush the waves to the shore. This wind is the wind of the Spirit, "the viewless wind" to which the poet must open the portals of his mind. Power lies with the Spirit. The place of man and nature is to surrender to that Spirit. (Robinson 106-107)

The passage speaks to the harmony Transcendentalists were always trying to find between external nature and their own inner nature. Whatever they believed independently to be the origin of life on earth, they could all agree that man was more akin to the organisms of nature than to the mechanisms of the industrial world, so in abandoning the agendas of modern infrastructure and giving themselves over to the natural Spirit, they could feel, at last, free. Emerson articulates the same philosophy in his "Divinity School Address":

> The spirit only can teach. Not any profane man, not any sensual, not any liar, not any slave can teach, but only he can give, who has; he only can create, who is. The man on whom the soul descends, through whom the soul speaks, alone can teach. Courage, piety, love, wisdom, can teach; and every man can open his door to these angels, and they shall bring him the gift of tongues. But the man who aims to speak as books enable, as synods use, as the fashion guides, and as interest commands, babbles. Let him hush. (Emerson 238)

Man cannot reach his fullest potential and understanding, cannot be actualized, unless he is open to the lessons of the spirit. This is the Truth that Emerson seeks. But perhaps the most compelling and effective resemblance between Emerson

and Very's poetic approach is in their application of Emerson's Theory of Correspondence, which Carl Dennis defines in his article, "Correspondence in Very's Nature Poetry," as "the theory that since mind and nature are made in correspondence, a proper natural instance can be found for any idea" (266). The theory explains the preoccupation of Transcendentalist poetry with nature metaphors. The mind, the soul, the spirit belong to nature. They speak the same language. And so when the poet sets about to articulate some truth, he will always find it demonstrated in nature. Of course Emerson explains this in his "Address" as well: "Speak the truth," he says, "and all nature and all spirits help you with unexpected furtherance. Speak the truth, and all things alive or brute are vouchers, and the very roots of the grass underground there, do seem to stir and move to bear you witness" (Emerson 233).

Very's poem "To the Canary Bird" is both a comment on the usurpation of nature and a metaphor for man's inherent desire to return, himself, to the freedom of the natural world:

> I cannot hear thy voice with others' ears,
> Who make of thy lost liberty a gain;
> And in a tale of blighted hopes and fears
> Feel not that every note is born with pain.
> Alas! that with thy music's gentle swell
> Past days of joy should through thy memory throng,
> And each to thee their words of sorrow tell,
> While ravished sense forgets thee in thy song.
> The heart that on the past and future feeds,
> And pours in human words its thoughts divine,
> Though at each birth the spirit inly bleeds,
> Its song may charm the listening ear like thine,
> And men with gilded cage and praise will try
> To make the bard, like thee, forget his native sky.
> (qtd. in Dennis 261)

The titular bird represents both nature and man. The speaker cannot sympathize with those "who make of thy lost liberty a gain," who profit from the corruption of nature: industrialization and miserable office jobs, the lumber industry, paved roads, itchy starched collars and the pursuit of cash. All the while the bird longs for a return to its natural habitat--to freedom: "The heart that on the past and future feeds," against overwhelming efforts "to make the bard, like thee, forget his native sky." The will of the spirit to be reunited with its nature is relentless.

Dennis reads the canary as "the analogue of the soul's longing for heaven" and suggests that the poet "does not simply use the bird as a means to express his own predicament, but rather uses his own predicament to empathize with the bird" (261-

262). A symbiotic relationship exists between man and nature, and Very constantly finds himself returning to it. So even when his work calls him to the controversial service of God, the poet finds his Spirit manifest in nature.

Very was an imperfect Christian and an imperfect Transcendentalist: fired from Divinity School, dismissed by most of the Concord Elite, and yet his pursuit of both was steadfast. Perhaps finding hardly a foot in either school allowed him to explore both with untethered innovation--and there isn't anything much more Transcendentalist than that.

About the Author

Kirsten Ridlen is a graduating senior majoring in English. This piece was completed in the fall of 2014 under the instruction of Dr. Ann Brunjes (English)

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Colonial Hybridity and Irishness in Bram Stoker's *Dracula*

Kristy Eve Snow

Introduction
A Brief Irish Colonial History & Stoker's Vampire

Ireland's political and colonial relationship with England can be traced back roughly one thousand years to the Norman Invasions of 1169. Over the next half a century, the English gradually took over the island and in 1603, following the Nine Years' War, the Irish were overpowered and Ireland became an English territory. After this victory, England began forcefully colonizing Ireland, and reimagining the island in its own image. While the land had previously been viewed as communal property, English property laws confiscated land from native Catholic families and partitioned it into individual holdings for settler purchase. Additionally, penal laws, which prevented Catholics from owning land or participating in government (among other restrictions), were enacted in an attempt to subvert and undermine native Irish Catholicism.

It was in this new, pseudo-English landscape that English settlers moved to Ireland and established themselves as the Protestant ascendancy minority through the purchase of land, and the filling of positions in the Protestant clergy and Irish Parliament. Margot Backus writes in *The Gothic Family Romance*:

> Through the process of resettlement in Ireland, a large number of persons, themselves economically and socially displaced, achieved stable positions in English society. [...]Paradoxically, only by remaining in Ireland could the settler colonialist participate fully in the national economic and political life of England. (23)

Incapable of upward class or political mobility on his native English soil, the Anglo-Irish settler reinvented himself as an absentee, but nevertheless, aristocratic member of English society. Thus, the displaced Anglo-Irish colonizer, in an attempt to legitimize his position as a chiefly English dignitary, labeled the native Irish as both racially and nationally "other." He designated in his Irish counterparts those traits he did not want to recognize in himself, and in doing so, prevented Irish class mobility much like the imperial English had prevented his. The once displaced Anglo-Irish prevented the Irish peasantry class from progressing through an antiquated feudal system and leasing land for tenant subsistence farming. This antiquated structure of land-ownership continued well into the nineteenth century and exacerbated the devastation of the Irish Potato Famine of 1845-1852. It also exaggerated the imperial condemnation of the Irish as a "diseased stock," as over one million people died of starvation, poverty, and famine-related illnesses (Gibbons 43). In his article "The Cultural Effects of the Famine," Kevin Whelan argues that while the Famine stagnated the culture of Ireland in the immediate post-famine period, it later prompted vast cultural changes in the post-famine generation of the 1880's—including the centralization of the Catholic Church as a moral and religious authority, as well as the core of Irish national identity. The post-famine generation sought to produce an Irish cultural identity that was previously ruined or prevented by the political and social injustices related to the Potato Famine. They sought to rewrite the Irish history that was taken from them by tragedy, and reinvent Irishness as an identity that was chiefly anti-English.

At the end of the nineteenth century, as the one-time colony rapidly approached nationhood, the fight for Irish nationalism advanced. Subsequently, the Anglo-Irish ascendancy culture deteriorated. The class was loathed in Ireland and without a place in a modernizing England. In this fin de siècle landscape, Ireland was seen as being occupied by two opposing, and religiously charged, forms of Irishness—the Protestant Anglo-Irish, who supported the union of England and Ireland, and were viewed as essentially English, and the Catholic nationalists, who asserted that Ireland should be a sovereign nation ruled by the Catholic majority.

Religion was not all that divided the island. Imperial conceptions of gender and family were simultaneously extended to and withheld from the Irish people. Joseph Valente writes in his book, *The Myth of Manliness in Irish National Culture*, 1880-1922: "On one side, the Irish were enlisted as foot soldiers of empire, and so bound to the ethos of manliness; on the other, they were reduced to inmates of empire, and thus stigmatized as manhood's other" (19). The Anglo-Irish, linked to the English through Anglo-Saxon bloodlines, asserted themselves as the manly counterpart to a feminine native-Irish population. Each group viewed the other as a threat to Ireland's security, and as a mode of cultural and racial contamination. Despite these opposing classifications, there were Irish people belonging to more hybridized subject positions who struggled with a socially created racial and gender anxiety. In his book, *Dracula's Crypt*, Valente writes: "This psychosocial condition, the relationship of the subject with his own immixed otherness closely resembles the vampiric condition in Dracula, the

relationship of subject-victims with their undead emanation or doppelganger" (18).

Bram Stoker's *Dracula* is the story of an English solicitor, Jonathan Harker, who travels to Transylvania to negotiate the sale of English real estate, and secure his position in bourgeois society. However, this transaction leads him to the vampire, Count Dracula, who uses Jonathan as a means to travel to London and feed on Harker's fiancée and friends. Despite drinking Dracula's blood, Harker's fiancée survives the encounter with the vampire, and, with the help of a band of men, Harker is able to kill the Count. However, the birth of Jonathan's baby, who holds the blood of all of the novel's characters through the earlier vampiric exchanges, signals the hybridity of the next generation.

Stoker's novel demonstrates that the binary opposition between the colonizer and the colonized does not hold because it cannot be clearly defined or recognized. Instead, the paradigm produces a complicated, hybridized subject position with an uncertain future in a modern landscape. Through *Dracula*, Stoker interrogates colonialism and the future of the nations that emerge from it. He also questions where progress lies in the wake of a colonial past, and in a society which seeks to dichotomize identities.

English Subjectivity Confronts the Colony

Jonathan Harker, the first character to lend his narrative to *Dracula*, epitomizes modern English, middle-class subjectivity—a social role continually created and recreated by social contexts. As a newly certified solicitor, Harker travels to Transylvania to negotiate the sale of London real estate to the reclusive and aristocratic Count Dracula. While in pursuit of an idealized bourgeois lifestyle, Harker's journey forces him to confront an antiquated landscape, fierce Catholicism, and a feudal vampire. Thus, as Harker moves further from London and further from the luxuries of modernity, like trains that run on time (Stoker 28), he becomes bond between the contemporary and the historical, and consequently a bond between the colonial conquests of the past, and the post-colonial future. Through Harker's encounter with outmoded Transylvanian society, Stoker suggests that are no clear racial or national distinctions in colonial discourse. In order to achieve class mobility and to become the self-sufficient man he longs to be, Harker needs to address the colonial condition that produced his subject position. Similarly, instead of viewing the colonized other as its opposite, English subjectivity must confront and recognize the internalized aspects of the other within itself, and embrace its hybridized identity.

While the text never explicitly mentions Ireland, Harker's description of the Transylvanian landscape resembles the writing of English travel journals describing the Irish countryside and its occupants. Harker writes of "[historical] casualties of war proper being assisted by famine and disease" (29). He also describes the "green sloping land full of forests and woods, with here and there steep hills crowned with clumps of trees or with farmhouses" (32), and roadside shrines and crosses vehemently worshipped by the locals (33). His account of the landscape gestures to the English version of Ireland with its "green sloping land," "farmhouses," and roadside crosses, all serving as indications of an agrarian, Catholic nation.

Although the above descriptions might mirror a depiction of Ireland, Joseph Valente argues in his book *Dracula's Crypt* that one should not view them as a direct catalog, but the evocation of a history of constructing colonial otherness:

> [W]e must not draw the customary inference that the social landscape of Stoker's Transylvania deliberately and directly evokes the conditions of contemporary Ireland, but rather that Harker's report on Transylvania evokes a multigeneric, multiethnic, and multiperspectival construction of Ireland that had developed, unevenly, over an extended period. (53)

Stoker utilizes Jonathan Harker as the English lens through which Transylvania is described. Despite the Irishness implicit in Harker's narrative, Stoker sets *Dracula* in Transylvania and, in doing so, illuminates the irony of the imperial worldview conflating all colonial others. While the descriptions of the landscape are not derogatory in and of themselves, Harker's attitude towards the location and its occupants indicates his innate imperial sensibility, and his intrinsic desire to designate the Transylvanian occupants as "other" or opposite. In his journal, Harker criticizes his surroundings as the home of "every known superstition in the world" (28) and comments on the peasants' inappropriate attire. However, as Luke Gibbons argues in his book *Gaelic Gothic: Race, Colonization, and Irish Culture*, "race and empire begin at home, and… both colonization and the animus against Catholicism were inherently bound up with the subjugation of the Celtic periphery…" (11). While the colonizer justifies the conquest of the colonized through faith-based prejudices, those loathed qualities of Catholicism—namely superstition—transcend religious discourse, and are instead indicative of the dialectic relationship between colony and colonizer.

Although Harker vehemently contrasts Transylvania with England throughout his visit, he later utilizes some of the Catholicism and "superstition" that he previously criticized. On page 31 he accepts rosary beads from a peasant woman, and clings to them during his fearful journey. Throughout

the novel, Harker utilizes Catholic-based objects, including rosaries, communion wafers, and crucifixes, as primary modes of protection against the vampire, proving that while he identifies himself as "an English Churchman"(31), his anti-Catholicism is ambiguous, and bred from a "multigeneric," "multiperspectival" construction. In other words, the animus of colonialism inflicts both the colonizer and the colonized. While the colonizer inherently wishes to "other" and oppose itself to its colony, the act of imperialism instead bonds the two. This leads to the conflation of qualities, and the act of designating one's opposite becomes more complex. While Jonathan Harker might dismiss the Transylvanians as archaic and superstitious, he clings to their values for his protection. Throughout his journey, Harker's inability to easily designate rationality from superstition, or self from other, becomes more prevalent. As he begins to approach Dracula's castle, Jonathan is forced to confront the shifting and plural construction of his unique subject position.

The Man in the Mirror: Freud & Bhabha

While Jonathan Harker and Count Dracula might appear to be contrasting figures occupying distinct positions in a binary opposition, Stoker confuses and averts clear-cut antithesis through character doubling. Also referred to as a doppelgänger, Sigmund Freud describes the experience of the double in *The Uncanny*, writing: "[A] person may identify himself with another and so become unsure of his true self; or he may substitute the other's self for his own. The self may thus be duplicated, divided and interchanged" (142). When considering the motif within colonial discourse, the double becomes a mechanism for the colonizer to identify within the colonized those traits which he represses, and thus, a means to justify the oppression of the colonized. At the end of the Victorian era, when *Dracula* was written, the double served as criticism of the Victorian impulse to juxtapose people as either good or evil, masculine or feminine, dominant or subordinate, as well as colonizer or colonized (Kiberd 38). The doppelgänger effect demonstrated that within one subject position are infinite, fluid qualities challenging antithesis.

Resisting clear allegory, Stoker combines in each character disparate notions of the colonial relationship. The Count, on the one hand, resembles an imperial, masculine force—commonly associated with the British Empire. On the other hand, the vampire's archaism and racialized "otherness" aligns him more closely with stereotypes of all colonized others. Similarly, Harker signifies the working class, feminized vision of the colonized, but is fundamentally the model of modern British subjectivity. While occupying different physical bodies, the characters of the vampire and Harker conflate the literal with the repressed, as well as the modern subject with

the racialized other. Homi Bhabha discusses the concept of colonial imitation in his article, "Of Mimicry and Man: The Ambivalence of Colonial Discourse." According to Bhabha, mimicry occurs when a colonized society imitates its colonizer to the point of near indistinguishability. Borrowing from Jacques Lacan's essay "The Line and the Light," Bhabha writes, "The effect of mimicry is camouflage…It is not a question of harmonizing with the background, but against a mottled background, of becoming mottled…" (Lacan qtd. in Bhabha 85). In mimicking, the colonized never achieves complete synchronization with the imperial culture, and is left, instead, in a position of self-doubt. However, in mimicking the oppressor, the colonized gains a subversive advantage and in post-colonial discourse should embrace hybridity as a means of reinvention (Gupta 1-10). Many scholars have argued that the section that perhaps most unifies Harker and Dracula as doubled characters occurs in chapter 2 of the novel when Harker writes in his journal:

> I had hung my shaving glass by the window, and was just beginning to shave. Suddenly, I felt a hand on my shoulder, and heard the Count's voice saying to me, 'Good morning.' I started for it amazed me that I had not seen him, since the reflection of the glass covered the whole room behind me. In starting I had cut myself slightly, but did not notice it at the moment. Having answered the Count's salutation, I turned to the glass again to see how I had been mistaken. This time there could be no error, for the man was close to me, and I could see him over my shoulder. But there was no reflection of him in the mirror! The whole room behind me was displayed; but there was no sign of a man in it, except myself. (50)

While this description may signal the paranormal or supernatural, I argue, instead, that Harker is recognizing his own innate hybridity but is mentally unequipped to recognize it.[i] While shaving, Harker is positioned in front of both a mirror and a window—two means of self-reflection, and one of illumination. The act of shaving expresses Harker's need to transform himself into the modern, British gentleman—a position he is on the brink of achieving as a newly established solicitor. However, his transformation is stalled when his repressed other surfaces in the form of the Count. In a state of amazement, an indication of the sublime in the Gothic genre (Kilfeather), Harker is unable to break free of his limited perspective. Instead, as stated previously, Harker is imprisoned within a domestic space—observing the whole room in the reflection of the mirror. In his confinement, he is also trapped in an infantilized stage of development.

Although Harker is literally partaking in a state of self-reflection, he is not addressing the Count as a part of himself, but as a separate man, and in doing so is preventing himself from having a cohesive identity. Freud argues in *The Uncanny* that, "in the pathological cases of delusions," the double becomes a distinct entity, created by the observer and infused with those traits belong to his own "superannuated narcissism of primitive times" (142-143). Harker, as a representation of British subjectivity, is confronting Dracula as an embodiment of its own repressed imperial history. Rather than occupying a "true-self," or regarding his subject position as innately hybrid, the English Harker, in a state of "primitive narcissism" divides himself into two men—Jonathan and Dracula; the latter of the two becoming the object on which his own suppressed traits are projected. While Harker longs to escape Dracula, and later murder him, Declan Kiberd writes, "killing or annihilating the double is no final solution, for his life and welfare are so closely linked to that of his author as are the Irish to the English, women to men, so on. No sooner is the double denied than it becomes man's fate" (42). Considering this scene within an Irish subtext, the Count represents the colonial other—intimately tied to both English and Irish national identity, but rejected by both.

Gender & Colonialism
During the Victorian era, gender roles were highly debated and the attributes of each sex were strictly policed. Traditional Victorian gender roles—roles created by a patriarchal society—portrayed the ideal woman as virginal, subservient, and entirely domestic, while men were expected to be dominant, unemotional, and intelligent. During this time, the tendency of men to categorize women through the virgin/whore binary—the notion that a woman is either pure and submissive, or sensual and unruly—was also commonplace. *The Madwoman in the Attic* by Gilbert and Gubar discusses this dichotomy and describes Victorian society as "a society where women are warned that if they do not behave like angels they must be monsters" (29). In *Dracula*, these larger gender implications are projected onto the psychosexual dynamic of the characters, with each occupying a hybridized version of prescribed gender roles (Kelfeather 79). Stoker treats gender as a fluid categorization, moving in and out of the expected norms, and through this interrogates the sexual aspect of the colonial relationship.

During the colonial period, Victorian gender roles became synonymous with the colonial relationship, with the colonizer embodying masculinity, and the colonized acting as the feminine. As Meaney writes in *Sex and Nation: Women in Irish Culture and Politics*:

> [A] history of colonisation is a history of

feminisation. Colonial powers identify their subject peoples as passive, in need of guidance, incapable of self-government, romantic, passionate, unruly, barbarous—all of those things for which the Irish and women have been traditionally praised and scorned. (qtd. in Gray 87)

As Ireland moved closer to nationhood, the traditional construction of the masculine England and feminine Erin did not abate. Rather, the gender construction was internalized and reappropriated onto Irish women—newly stereotyped as a romantic, idealization of the Irish land (Valente 25). Irish women and the Irish national body became a feminine figure for the Irish male population to protect. Stoker criticizes this reappropriation in *Dracula*, and seeks to break the internalized gender norms of the Victorian Era.

Jonathan Harker's encounter with the three female brides of *Dracula*, or the "weird sisters" to borrow from *Macbeth*, exemplify the consequences of an extreme form of gender hybridity. The sisters represent a cruel and impulsive hyper-masculinity in a female form, occupying the monstrous space in Gilbert and Gubar's described binary. These women seek to destroy children rather than create them, and exude a domineering sexuality that Harker struggles to resist:

> All three had brilliant white teeth, that shone like pearls against the ruby of their voluptuous lips. There was something about them that made me uneasy, some longing and at the same time some deadly fear. I felt in my heart a wicked burning desire that they would kiss me with those red lips. (61)

In a prostrate position, Harker fixates on the vampires' mouths. He longs for the women to bite him with their phallic teeth, but also fears complete victimization. Although Harker is attracted to these female vampires, who Stoker refers to as "voluptuous" numerous times, he is also aware of the danger of giving into their seduction; a vampiric penetration that would lead to his death. Joseph Valente points out in *Dracula's Crypt* that Harker's conflictual desire to maintain his masculinity but be feminized by the vampiric bite is bred from his complex subject position—English with an intermixed colonial other (Valente 18). While Dracula represents the patriarchal Anglo-Irish ascendancy on the brink of extinction, his brides represent the uncertain future of women outside of the colonial relationship. Although some have argued that Stoker's writing is misogynistic, I want to suggest that Stoker is struggling to combine disparate ideas of gender—one extremely prudish and heavily enforced by popular culture, the other hyper-sexualized and repressed—in these female villains. The female vampires are the hyperbolic

expression of a woman embodying Victorian masculine traits, or the severe consequences of the New Woman—a nineteenth century iconographic, progressive female who disregarded social gender norms (Eltis 452). Through them, Stoker questions the gender dynamic of a post-colonialist space. Rather than calling for an inverted gender relationship, Stoker calls for a more balanced hybridity.

Mina Harker (nee Murray) is the most hybridized female representation in *Dracula* because of her professional endeavors as a schoolmistress and her desired domesticity in her relationship with Jonathan. She blends prescribed gender roles, breaking free of an entirely domestic life while still proclaiming her devotion to her husband. Mina resists the New Woman label because of her commitment to being useful to her husband and his male friends. However, she maintains control through the compilation and editing of the journals and sources that comprise Dracula. Van Helsing, the leader of the men who kill Dracula, compliments Mina's dual-nature, saying:

> Ah, that wonderful Madam Mina! She has a man's brain—a brain that a man should have were he much gifted—and a woman's heart. The good God fashioned her for a purpose, believe me, when He made that so good combination. (240)

Mina represents Stoker's ideal conception of the nation. While she is feminine, and ultimately subservient to her husband (and later, Dracula), her rational ability allows her to thrive both domestically and within a larger social landscape. In colonial discourse, Mina becomes the ideal Ireland—self-governing but, still reliant on her male counterpart.

While others fall victim to vampiricism in the novel, Mina actively participates in it. While Dracula is able to seduce Mina, as he did her friend, Lucy, his seduction does not lead to Mina's demise. Instead, his blood enhances her and ultimately allows her to aid the men in the novel to destroy the vampire. Unlike the sexualized exchange of blood between Lucy and Dracula, Mina and Dracula's encounter appears far more maternal. Dr. Seward writes in his account of the scene:

> With [Dracula's] left hand he held both Mrs. Harker's hands, keeping them away with her arms at full tension; his right hand gripped her by the back of the neck, forcing her face down on his bosom. Her white nightdress was smeared with blood, and a thin stream trickled down the man's bare breast, which was shown by his torn open dress. (283)

This exchange clearly alludes to the act of breastfeeding. While Mina drinks from Dracula, her husband lies prostrate on the bed, unconscious and unaware of the unfolding scene. Rather than allowing this colonial force drain life from her, Mina is nourished by their encounter. While Dracula does drink from Mina, he also replenishes what he has taken. This exchange represents the ideal relationship between the colonizer, England, and the colonized, Ireland. Rather than opposing each other, or allowing one entity to take advantage of the other, their relationship is mutually beneficial. Despite the mutual nourishment, the men of Dracula, with Mina's help, are able to destroy the Count.

The Death of the Vampire and The Birth of the Nation
Dracula's death scene is surprisingly anti-climactic and somewhat ambiguous. After Mina drinks from the Count, she is able to sense his location telepathically. The men use her ability to follow Dracula back to Transylvania where they appear to kill him:

> [O]n the instant, came the sweep and flash of Jonathan's great knife. I shrieked as I saw it shear through the throat; whilst at the same moment Mr. Morris's bowie knife plunged into the heart. It was like a miracle; but before our very eyes, and almost in the drawing of a breath, the whole body crumbled into dust and passed from our sight. (367)

While Dracula seemingly disappears, his killing is not as explicit as Lucy's. His throat is only slit, rather than his head removed, and his heart is pierced with a knife and not staked. Nonetheless, he appears to be destroyed. Dracula's death is fully mobilized—the men fight around a moving carriage, and his murderer is the once impotent Jonathan Harker. Jonathan's transformation from stagnant to active male represents the transformation of his once limited perspective. Through this scene, Stoker argues that national sovereignty is possible for Ireland, but only after a mutually beneficial relationship with England is established through the Home Rule movement.[ii] Mina, with her man brain and Dracula blood, is the means by which the men are able to free themselves from the Count. However, *Dracula*, as an earlier conceptualization of the nation, is imagined and has the potential to be outwardly projected again. In other words, sovereignty does not signal safety because capitalism and colonialism are so deeply implanted in the concept of nation.

The birth of Quincey Harker concludes the novel and signals the necessary hybridity of future generations. The child of Mina and Jonathan literally holds the blood of all of the major characters of *Dracula*; Mina and Jonathan through birth, and the blood of Dracula, Lucy, and the men through Lucy's

transfusions. He is the ultimate manifestation of Irish hybridity.

Conclusion

Benedict Anderson argues that the concept of the nation is inwardly imagined, and projected by its occupants. Because it is imagined, the national identity is also limited to the classification conceived by its creators. Although Ireland strives for sovereignty, the institutions it most fears and loathes—particularly colonialism—are so intimately tied to Irishness that they cannot be escaped. In projecting the nation, Ireland will undoubtedly need to acknowledge that those institutions that it dreads are necessary within national discourse, and connected to the Irish subject position through its colonial history. Through *Dracula*, Stoker argues that Irishness is a fluid identity, bred from the history it longs to forget, and imagined in multiple forms.

Endnotes

[i] Further supporting this reading, Dracula is greeting Harker in the morning, contradicting the nocturnal reputation of vampires.
[ii] Irish Home Rule argued that Ireland should stay under the dominion of England, but practice self-government.

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About the Author

Kristy Eve Snow is a graduating senior majoring in both English and Philosophy. Her research project was completed under the mentorship of Dr. Ellen Scheible (English) and made possible with funding provided by an Adrian Tinsley Program summer research grant. This paper was accepted at the 2015 National Conference on Undergraduate Research. Kristy plans to pursue her MA in English in the fall of 2015.

Is the U.S. Missing Out? The Effects of Parental Leave Benefits on Business

Katharine West

Most of the developed nations in the world have instituted comprehensive maternity (and sometimes paternity) leave programs, many of which offer paid time off for new mothers. Recently, there has been increasing focus on the maternity leave laws in the United States, which grants new mothers a leave period, without wage compensation, much shorter than the world average. The twelve weeks of unpaid leave mandated in the United States is comparable with the benefits offered in Papua New Guinea, Swaziland and Lesotho, rather than those in other similarly developed nations. For instance, the International Labor Organization reports that Canada offers mothers up to eighteen weeks leave at fifty-five percent of their wages; in Brazil, mothers receive one hundred twenty days at full pay; and in Belgium maternity leave is fifteen weeks long, with the first thirty days compensated by eighty-two percent of wages and seventy-five percent for the remainder of the leave.

In 1993, the United States enacted its first, and currently only, regulations regarding maternity leave. The Family Medical Leave Act of 1993, FMLA, grants employees twelve weeks of unpaid leave after the birth or adoption of a child and guarantees their position will still be available upon return. This benefit is only mandated for employees who have accrued over 1,250 hours and have been employed for at least a year at a firm with over fifty employees. This leaves approximately forty percent of the population uncovered because they are employed at either medium or small businesses (Bernard). Many employers claim that parental leave programs are too costly and choose not to offer any parental leave benefits beyond FMLA mandates. Would it harm the employers in the United States if they followed the rest of the world and offer increased parental benefits for employees who have new children? Or, could more comprehensive family benefits packages actually benefit businesses by increasing employee loyalty and productivity?

Studies have shown definite societal benefits from offering longer and assisted parental leaves. Parents have more time to bond with their child, and longer leave periods have been correlated with longer periods of breast-feeding. Breast-feeding has been linked to lower infant mortality rates, along with a great number of future health benefits for both the mother and child (Ogbuanu et al.). A healthy future generation has lower healthcare costs, something many in the United States are calling for. In 2002, the Pan American Health Organization published "Quantifying the Benefits of Breastfeeding: A Summary of the Evidence." The authors, Chessa Lutter, Jay Ross, Luann Martin and Natalia Leon-Cava, estimated that increasing the breastfeeding rates from the 1998 levels to the Surgeon General's current target levels would save no less than $3.6 billion (116). One study used in the estimation followed 617 infants through their first year; the study concluded that non-breastfed infants incurred an additional $331 to $475 in medical related costs in comparison to breastfed infants (117). Since firms are mandated to provide employee health insurance, lower societal healthcare costs benefit the firm.

Are the short-run costs incurred by employers offering paid parental leave benefits great enough to justify the opportunity cost of the societal benefits? The lack of regulations would lead one to believe that the costs must outweigh the benefits. However, this is not the case. Christopher Ruhm, Associate Dean and Professor of Public Policy and Economics from the Frank Batten School of Leadership and Public Policy at the University of Virginia, has written a number of papers on the topic for the National Bureau of Economics. In the abstract for the paper he co-authored with Jackqueline Teague they assert "the econometric estimates provide little support for the view that moderate periods of parental leave reduce economic efficiency but rather hint at a modest beneficial impact, particularly when considering paid time off from work."

Jody Heymann, the Dean of the Fielding School of Public Health at the University of California, Los Angeles, notes in an article published by the *New York Times* that "beyond the marked health advantages, paid maternity leave yields economic gains in terms of reduced health care costs, reduced recruitment and retraining, and improved long-term earnings for women" (qtd. in Bernard). Given these comments, there is reason to believe that employers can also reap the benefits of maternity leave. Skilled labor is often difficult to find, and the process of hiring a new employee can be costly, especially in industries that require highly educated specialists. Employers would rather retain an employee than replace one; in addition to time lost to interviews and training, along with potential recruiter fees and signing bonuses, a great deal of time and resources are diverted from the most efficient uses.

Google, the multinational internet services and products giant, is an example of a company that has profited by implementing

additional maternity leave benefits for employees. In 2007, after discovering that women were leaving the company at twice the rate of men, the maternity leave policy for new mothers was amended to offer five months of paid leave with full benefits. Once the policy change was implemented, the retention rate of women matched that of their male counterparts. Google's head of Human Resources, Laszlo Bock, notes that the reason for the policy change was not only to increase retention and employee satisfaction but also because by factoring in "the savings in recruitment costs, granting mothers five months of leave doesn't cost Google any more money" (Manjoo). However, while Google's leave policy is extremely generous, the rate of attrition is of much higher concern than in industries where workers with basic skills are sufficient. Nevertheless, frequent turnovers are costly even for firms that do not hire highly skilled workers. Time lost to training and inexperience means less productivity and lower efficiency.

In a 2009 paper published by the Institute for Women's Policy Research, IWPR, the authors advocate the implementation of a paid parental leave program for federal employees. The federal government employs more workers than any other firm in the United States, and many current federal employees are highly skilled and approaching retirement age. In order for the federal government to compete with the private sector and recruit new talent for replacements, the IWPR argues the need to increase the parental benefits currently offered. The private sector, in order to compete for and retain the best employees, offers enticement in the form of leave programs far more comprehensive than mandated. In order for the federal government to recruit the top job seekers, similar benefits must be offered (Miller, Helmuth, and Farabee-Siers 5).

The competition for talent was the reason that Ascensia, a British global management consulting firm, introduced a nine-month paid maternity leave program. In the documentary, *Why Can't a Woman Succeed Like a Man?*, Director of Human Resources Dan Flynn and Senior Executive Anne Gardner were asked why the company chose to offer such a long period of paid leave. Flynn states that the policy helps the company succeed because, "the way we make money is we sell clients the ideas, thoughts and skills of some of the best people in our industry and therefore it is critical we have the best people working for us." Gardner echoes his sentiments, saying the payoff for the company is that the leave program ensures "the best people working in the environment" are working for their firm. Not only does this policy aid Ascensia during the recruitment process, it also helps in the retention of top talent; nearly all new mothers who work at Ascensia return after the given leave period. The increased retention rates that result from paid leave are another reason why IWPR supports a

paid leave policy for federal employees. They estimate that the government could save over fifty million dollars by offering paid parental leave benefits:

> Improved employee retention would yield substantial government savings by reducing the costs associated with staff turnover. Recruiting new employees, the relatively low productivity of new hires, drains on the productivity of colleagues and supervisors, human resources processing time, training, and lost productivity between the departure of an employee and the hiring of a replacement are all real costs to employers. (Miller, Helmuth, and Farabee-Siers 9)

California was the first U.S. state to implement a family leave policy exceeding federal government mandates. Currently New Jersey, Rhode Island and Washington are the only other states that have mandated paid maternity leave policies. The 2004 California's Family Rights Act, CFRA, increased benefits offered to employees with new children. In addition to the 12 weeks of unpaid leave granted by the FMLA, CFRA offers six weeks of leave paid at a percentage of the mother's wage. In 2002, before CFRA was passed, economists Arindrajit Dube and Ethan Kaplan from the University of Chicago and University of California, Berkley respectively, predicted that the implementation of the paid leave program would "produce substantial cost savings for employers" and also savings for the state of California (49). Their analysis estimated eighty-nine million dollars in savings for employers caused by reduced turnovers and twenty-five million dollars in savings for the state that can be attributed to reduced transfer payments (5).

In 2011, a study conducted by the Center for Economic and Policy Research "found that 89% of employers surveyed reported that the state's policy had either a positive or no noticeable effect on productivity. An even larger portion of employers found that the policy had a positive effect or none at all on profitability and performance, turnover, and employee morale" (Zillman). The results of this study supported the conclusion of Dube and Kaplan's foundational work that employers would not be adversely affected by offering paid leave. Additionally, California's paid leave program is funded by taxing employee wages, relieving the employer of the financial burden of paying for an employee who is not currently contributing.

Employers may feel that they are disadvantaged by a mandated maternity leave policy because they are required to hold a job open for an employee that is not contributing to production. They can either spread the responsibilities of the missing employee among the rest of the staff or they can hire a

temporary replacement. There is, obviously, some impact on productivity. However, because comprehensive leave benefits are proven to reduce turnover and increase productivity, the advantages outweigh the costs to firms offering these programs (Rhum 7). Christopher Ruhm, in collaboration with Maya Rossin-Slater and Jane Waldfogel, determined in their paper that once CFRA went into effect, there was a six to nine percent increase in the hours worked by mothers before and after their leave periods. The authors attribute the increased commitment to the job security provided by CFRA (19). Employers benefit from not only added the loyalty that results from maternity leave programs, but also the added productivity of committed female employees.

A 2012 report by Rutgers University Center for Women and Work found that "paid family leave may strengthen women's workforce attachment and workforce stability by allowing women to retain employment both before and after a birth, particularly employment with the same employer and at the same, or better, wage. This benefits the woman, her family, and – by reducing turnover costs – her employer" (Houser and Vartanian 7). Similarly, after studying the economic outcomes of the parental leave polices in Europe, Christopher Rhum wrote "it is frequently asserted that parental leave raises levels of firm-specific human capital, by allowing women to return to their old jobs after having children. This elevates the marginal revenue product of workers" (7). Maternity leave policies that induce commitment reduce turnover and increase productivity, thus decreasing the marginal cost of labor.

All of the results examined here show the same outcome; employers benefit by offering comprehensive parental leave programs. When a firm offers paid leave, they are able to maximize human capital investment. Efficient labor means firms will maximize output and in turn profit. Therefore, in the interest of both the employee and employer, the most beneficial policy for the United States would entail an expansion of the benefits mandated in the Family and Medical Leave Act of 1993.

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About the Author

Katharine West is a senior Economics major. This paper was written for Managerial Economics taught by Professor Itler Bakkal. After earning her BS from Bridgewater State University, she plans to continue her economics education in a graduate program.

A Painted Smile
Mara Araujo

"A Painted Smile" is the final image of a video I created in the course Multimedia Storytelling. The assignment was to explore multimedia "apps" and consider how they can contribute to how we tell stories digitally. We each took photos, created a slideshow, and set it to music. The results show how technology is allowing storytellers to explore, document, and showcase their work in new and intriguing ways.

Since I find myself drawn to the creative process, I wanted to explore in my piece the childlike wonder we might feel when observing artwork being created in front of us. It is not uncommon for someone to observe a finished work of art and wonder how the artist conceptualized the project and went about creating it. That curiosity and admiration for how artists create their work inspired me to create a multimedia video that captures each stage of the process.

Both the title and the image of my video allude to Leonardo da Vinci's "Leda." To replicate a step-by-step process by which da Vinci's painting might have been created, my video incorporates both digital photographs and a digitally painted portrait into an iPad application called ArtRage. I began by hand drawing the portrait and photographing each stage of the process, including details such as the initial opening of the sketchbook. The last photograph documenting the process represents the completed drawing. The photographs were then uploaded into ArtRage, which automatically processed the still images into a short stop-motion video. I imported the photographs and painting stills into Apple iMovie and added some complementary audio, turning it into a multimedia presentation. The music served to enhance the concept of transforming the white canvas into a colorful portrait.

Similar to impressionist paintings that invite viewers to complete the image by visually merging the broken paint strokes into a cohesive work, "A Painted Smile" encourages the viewer to observe and question as the work takes shape. While watching how the painting was made, the viewer can learn or gain insight into how artwork is created.

Because the artwork was created digitally, I also hope that those who view the process might gain a better understanding of the complexities involved when producing digital paintings. At a time when digital tools such as Adobe's Photoshop are common, it is easy to dismiss digital artwork as artificial or inauthentic. However, with an app such as ArtRage, or any other digital painting application, artists are still creators; it is only the tools that have changed. **DIGITAL ART**

BUSINESS MANAGEMENT
& MARKETING

Undergraduate research in Bridgewater State University's Ricciardi College of Business includes applying data-driven and model-based methods to decision-making processes in myriad industries, from solar power to smartphones. Collecting first-hand data from manufacturers and potential customers, and then analyzing the implications of that information, not only deepen students' understanding of industry, but also inform their predictions of future trends.

Students also utilize advanced models such as Data Envelopment Analysis (DEA) to dig into troves of secondary data and make reliable comparisons for purchasing decisions based on efficiency or other criteria. In the articles that follow, students apply DEA optimization models in order to recommend particular choices, even in complicated cases of multiple outputs and inputs.

Through undergraduate research, business majors gain the problem-solving skills most highly valued by employers: accurately identifying the problem, seeking alternative approaches, thinking critically, deriving solutions, interpreting data to make informed decisions, and communicating those insights with stakeholders. Our students are applying theory to the practice of management, bridging the gap between the concepts taught in business school and complex, real-world situations.

Selection of Inflatable Bounce Houses Using Data Envelopment Analysis

Janice Bowen & Rebecca Uboldi

Introduction

Inflatable bounce houses were first introduced in Shreveport, Louisiana in 1959. John Scurlock, a mechanical engineer, had an idea while watching his employees bounce on an inflatable tennis cover he had recently designed. When he saw how much fun his employees were having, Scurlock created an inflatable floor for recreational purposes. Scurlock's idea evolved into a company called "Space Walks." Originally, the space walks were basically inflatable mattresses, but the design soon evolved into a bounce type structure complete with walls and circulating air for inflation. The structures were referred to as Moonwalks and became quite popular during the Space Race in the 1960's. Soon after, safety regulations were passed in the United States and the United Kingdom, and the industry of inflatable structures was born (2012, May 30).

The popularity of moonwalks developed the inflatable rental industry, which includes such inflatable structures as slides, obstacle courses, games and more. Inflatable house rentals are popular items for birthday parties, fundraising events, and festivals. The price to rent an inflatable bounce house for one day in the southeastern region of Massachusetts ranges from $125 to $295, depending on the size of the structure. The rental price often includes delivery and set up, but additional charges may be incurred for deliveries made outside of the rental company's delivery area. The cost to purchase a bounce house ranges from $50 to $500 depending on the size and features. As a result of the price to rent an inflatable house for one day, many parents and potential renters find it more economical to purchase an inflatable bounce house rather than rent multiple times.

Consumers may have a difficult time deciding on an inflatable bounce house to purchase because, in addition to cost, a variety of features, such as structure size, weight capacity, weight of product, customer ratings, and number of customer ratings must be compared. A customer may be concerned with the size of the structure, while a different customer looks strictly at price. The purpose of this paper is to use Data Envelopment Analysis to determine which inflatable bounce house is most efficient. In this study, twelve inflatable bounce houses have been compared. The input variable is the cost of the inflatable house. The output variables are customer ratings, number of customer ratings, product size, product weight, and weight capacity. The product weight is viewed as a negative output because a heavier bounce house may be more difficult for the consumer to transport and set up, which would not be a positive feature.

Literature Review

To our knowledge, there are no academic research papers directly using the Data Envelopment Analysis (DEA) model to assist in the selection of inflatable bounce house. However, there are published papers that compare and select various consumer products using the DEA model to, such as smartphones (Mustafa and Peaw, 2005), notebook personal computers (McMullen and Tarasewich, 2000), and automobiles (Papahristoudoulou, 1997).

DEA Model

DEA is a non-parametric approach to relatively evaluate the performance of a homogeneous set of entities referred to as Decision Making Units (DMU's) in the presence of multiple weight inputs and multiple weight outputs. DEA was first initiated by Charnes, Cooper and Rhodes (CCR) (Charnes et al. 1978) to compare the efficiency of multiple service units that provide similar services by considering their use of multiple inputs in order to produce multiple outputs. DEA can incorporate multiple inputs and multiple outputs into both the numerator and the denominator of the efficiency ratio without the need for conversion to a common dollar basis. As a result, the DEA measure of efficiency accounts for the mix of inputs and outputs and is more reliable than a set of operating ratios or profit measures.

DEA is a linear programming model that attempts to maximize a DMU's efficiency, expressed as a ratio of outputs to inputs, by comparing a particular unit's efficiency with the performance of a group of similar service units that are delivering the same service (Charnes et al. 1978). In the process, some units achieve 100 percent efficiency and are referred to as the relatively efficient units. The units that have efficiency ratings of less than 100 percent are referred to as inefficient units. The DEA linear programming model is formulated according to Charnes, Cooper, and Rhodes, and is referred to as the CCR Model, which is described below.

Definition of Variables:

Let Ek, with k = 1, 2, …,K, be the efficiency ratio of unit k, where K is the total number of units being evaluated.

Let uj, with j = 1, 2, …, M, be a coefficient for output J, where M is the total number of output types considered. The variable u is a measure of the relative decrease in efficiency with each unit reduction of output value.

Let vi, with I = 1, 2, …, N, be a coefficient for input I, where N is the total number of input types considered. The variable vi is a measure of the relative increase in efficiency with each unit reduction of input value.

Let Ojk be the number of observed units of output j generated by service unit k during one time period.

Let Iik be the actual units of input I used by service unit k during one time period.

Objective Function:
The objective is to find the set of coefficient u's associated with each output and of v's associated with each input that will give the service unit being evaluated the highest possible efficiency.

$$\text{Max } E_e = \frac{u_1O_{1e} + u_2O_{2e} + \ldots + u_MO_{Me}}{v_1I_{1e} + v_2I_{2e} + \ldots v_NI_{Ne}}$$

where e is the index of the unit being evaluated. This function is subject to the constraint that when the same set of input and output coefficients (u_j's and v_i's) is applied to all other decision making units being compared, no DMU will exceed 100 percent efficiency or a ratio of 1.0.

Constraints:

$$\frac{u_1O_{1k} + u_2O_{2k} + \ldots u_MO_{Mk}}{v_1I_{1k} + v_2I_{2k} + \ldots v_NI_{Nk}} <= 1.0 \quad k = 1, 2, \ldots, K$$

where all coefficient values are positive and non-zero.

To solve this fractional linear programming model using standard linear programming software requires a formulation. Note that both the objective function and all constraints are ratios rather than linear functions. The objective function is restated as a linear function by scaling the inputs for the unit under evaluation to a sum of 1.0.

$$\text{Max } E_e = u_1O_{1e} + u_2O_{2e} + \ldots + u_MO_{Me}$$

Subject to the constraint that:

$$v_1I_{1e} + v_2I_{2e} + \ldots v_NI_{Ne} = 1$$

For each service unit, the constraints are similarly reformulated:
$$(u_1O_{1k} + u_2O_{2k} + u_MO_{Mk}) - (v_1I_{1k} + v_2I_{2k} + vNINk) <= 0$$
$$k = 1, 2, \ldots, K$$

where:

$$u_j >= 0 \quad\quad\quad j = 1, 2, \ldots, M$$
$$v_i >= 0 \quad\quad\quad i = 1, 2, \ldots, N$$

Recommended sample size: K>= 2 (N + M)

Data and Preliminary Data Analysis
Our output variables include the following dimensions: 1) customer rating, which is based on a scale of one to five, with five being the highest rating; 2) number of customer ratings; 3) product size (in cubic feet); 4) product weight in pounds (excluding shipping weight); and 5) the weight capacity in pounds for each bounce house. Considering the challenges of transportation, consumers would prefer the lighter bounce house. Therefore this study treats the product weight as a negative output. This negative output needs to be treated differently because normally one would increase the output value to make the unit more efficient, but in this case, increasing the product weight would make the unit less efficient. As a result, the negative output has been treated as an input (Seiford & Zhu, 2002). The input variable is the price of the bounce house. Shipping prices were not evaluated because shipping could be free depending on whether or not the consumer has a Prime membership with Amazon. For the purposes of evaluating the most popular bounce houses, the data for the above inputs and outputs for each bounce house are shown in Table 1. All of the information contained in the data table was taken from the Amazon.com web site.

Results
This study employed the DEA model to formulate the entire problem, which was then solved through the Excel 2010 Solver. Twelve bounce houses were evaluated, and seven of them were found to be efficient using the DEA model. Bounce houses with scores of 1.00 are efficient when compared to the others evaluated. Bounce houses with scores of less than one are inefficient. Efficiency scores of all of the bounce houses that were evaluated are shown in Table 2.

Recommendations
Shadow price is the solution of the dual problem of the linear programming. In DEA models, shadow price provides the extent to which inefficient DMU's refer to efficient DMU's in order to become efficient. Recommendations for making the less efficient units more efficient are shown in Table 3. The results of Table 3 are summarized as follows:

•Little Tikes Triangle: To improve efficiency, the number of customer ratings should increase from 41 to 64; the product weight should decrease from 29.8 to 25.03; and the price should decrease from $185 to $138.81.

•Little Tikes Shady Jump 'n Slide: To improve efficiency, the customer rating should increase from 4.5 to 4.6; the product weight should decrease from 38.3 to 35.97; and the price should decrease from $239 to $224.44.

•Cloud 9 Mini Crayon: To improve efficiency, the number of ratings should increase by from 27 to 28; the weight capacity should increase from 300 to 309; the product weight should decrease from 51 to 45.32, and the price should decrease from $249 to $236.41.

•Cloud 9 Tunnel Course: To improve efficiency, the customer rating should increase from 1 to 2.94; the number of ratings should increase from 1 to 22; the weight capacity should increase from 300 to 327; the product weight should decrease from 46 to 42.5; and the price should decrease from $358 to $306.53.

•Bounceland Dream Castle: To improve efficiency, the number of ratings should increase from 20 to 52; the product weight should decrease from 45 to 37.11; and the price should decrease from $398 to $234.12.

Conclusion

Data Envelopment Analysis was used to compare twelve inflatable bounce houses in order to determine the most efficient. This simple tool can help the consumer compare the many different models of bounce houses that are available on the market. The results of this research showed that seven bounce houses were found to be efficient when compared to the others. Although the results cannot identify the best one for the consumer to purchase, they can narrow down the choices by ignoring the inefficient ones. As a result, the consumer can make a final decision according to personal needs, for example, choosing the one that best fits in their yard. Therefore, they can optimize their final decision.

Manufacturers of inflatable bounce houses also benefit from this study, especially those who produce inefficient ones. Using results of DEA models, manufacturers can improve the features of the current inflatable bounce houses or implement new strategies to improve customer evaluations. In addition, the information here can aid in the design of next generation products in order to gain a better share of the market.

Limited by the data resources, this study does not include some factors that might be important for customers when they select inflatable bounce houses. For example, the durability of the product, measured by the length of usage, could be an interesting dimension to investigate. Meanwhile, although this study treats the weight of the product as a negative output,

a subset of customers might argue that they would prefer a heavier bounce house because of durability and safety concerns. Future research would address the above concerns. Based on the application to inflatable bounce houses selection, the DEA model also can be applied to other purchasing decision making processes.

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Table 1. Bounce House Data Table

Bounce House)		Customer Rating (Scale of 1 to 5	Number of Customer Ratings	Product Size (Cubic ft.)	Weight Capacity (pounds)	Product Weight (pounds)	Price (US $)
Intex Jump O Lene Castle Bouncer	DMU_1	3.5	51	146	120	13.2	50
Intex Jump O Lene Transparent Ring	DMU_2	4	65	71	200	15.2	69
Intex palyhouse Jump O Lene	DMU_3	3.5	150	120	120	19	44
Little Tikes Triangle	DMU_4	4.5	41	374	250	29.8	185
Little Tikes Shady Jump 'n Slide	DMU_5	4.5	261	648	250	38.3	239
Little Tikes Jump 'n Slide Dry	DMU_6	4.5	365	648	250	37.5	257
Cloud 9 Mini Crayon	DMU_7	5	27	850	300	51	249
Cloud 9 Tunnel Course	DMU_8	1	1	1084	300	46	358
Cloud 9 Princess	DMU_9	4.5	18	867	300	45	239
Bounceland Castle with Hoop	DMU_{10}	4.5	334	756	250	40	259
Bounceland Dream Castle	DMU_{11}	4.5	20	803	300	45	398
Bounceland Pop Star	DMU_{12}	4.5	33	1658	500	65	469

Table 2. Bounce House Efficiency Results

DMU	Name of Bounce House	Eff Val.	Shadow Price											
			DMU 1	DMU 2	DMU 3	DMU 4	DMU 5	DMU 6	DMU 7	DMU 8	DMU 9	DMU 10	DMU 11	DMU 12
1	Intex Jump O Lene Castle Bouncer	1.00	1	0	0	0	0	0	0	0	0	0	0	0
2	Intex Jump O Lene Transparent Ring	1.00	0	1	0	0	0	0	0	0	0	0	0	0
3	Intex Playhouse Jump O Lene	1.00	0	0	100	0	0	0	0	0	0	0	0	0
4	Little Tikes Triangle	0.84	.3771	.6079	0	0	0	0	0	0	0	0	0	.1663
5	Little Tikes Shady Jump 'n Slide	0.93	.1736	.1427	0	0	0	0	0	0	0	.7232	0	.0397
6	Little Tikes Jump 'n Slide Dry	1.00	0	0	0	0	0	1	0	0	0	0	0	0
7	Cloud 9 Mini Crayon	0.94	.2145	0	0	0	0	0	0	0	.9443	0	0	0
8	Cloud 9 Tunnel Course	0.92	0	0	0	0	0	0	0	0	0	0	0	.6538
9	Cloud 9 Princess	1.00	0	0	0	0	0	0	0	0	1	0	0	0
10	Bounceland Castle with Hoop	1.00	0	0	0	0	0	0	0	0	0	1	0	0
11	Bounceland Dream Castle	0.82	.7327	.0122	0	0	0	0	0	0	0	0	0	.4193
12	Bounceland Pop Star	1.00	0	0	0	0	0	0	0	0	0	0	0	1

Table 3. Recommendations to Improve Efficiency

	Customer Rating (1-5)	Number of Ratings	Product Size (cubic feet)	Weighr Capacity (lbs)	Product Weight (lbs)	Price (US $)
Little Tikes Triangle	4.5	64	374	250	25.03	138.81
Little Tikes Shady Jump 'n Slide	4.61	261	648	250	35.97	224.44
Cloud 9 Mini Crayon	5	28	850	309	45.32	236.41
Cloud 9 Tunnel Course	2.94	22	1084	327	42.5	306.63
Boumceland Dream Castle	4.5	52	803	300	37.11	234.12

About the Authors

Janice Bowen and Rebecca Uboldi worked together to develop a study that would assist consumers in selecting and purchasing an inflatable bounce house through the use of Data Envelopment Analysis. Their project was completed in the fall of 2014 under the mentorship of Dr. Xiangrong Liu (Management). Janice will graduate in the spring of 2015 with a bachelor's degree in General Management at BSU. She works for the Department of Counselor Education at BSU. Rebecca will also be graduating in the spring of 2015. She is majoring in Accounting and Operations Management and minoring in Actuarial Science..
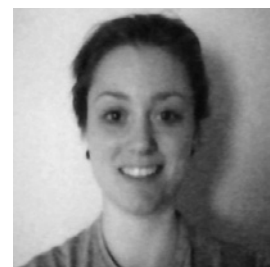
Exploring the Solar PV Industry: A Survey of PV Manufacturers in China

Patrick Prince & Bingqing Zheng

Introduction

The solar industry has grown significantly over the past decade. Photovoltaic (PV) technology turns solar energy into electricity. PV is a vital technology for the energy industry because it creates electricity during the day, when demand for electricity is at its highest. PV technology is also important because it creates electricity directly, as opposed to fossil fuel burning power plants, which require millions of gallons of water to produce steam and power the turbines that create electricity (Electricity Forum). This distinction is especially important for highly populated countries like China, where water is becoming scarcer (The Diplomat 2014).

Photovoltaic (PV) power generation uses modules, which are commonly referred to as "solar panels." Each solar panel is assembled out of a group of solar cells that are soldered together. The cells are made from thin slices of pure silicon called wafers. The wafers are manufactured to make two different types of solar cells: monocrystalline (mono) and polycrystalline (poly). The monocrystalline panels, while more efficient, are more expensive. Although polycrystalline panels are not as efficient as monocrystalline, they have a cost advantage over monocrystalline (Green 2000).

The Chinese solar industry, currently the largest producer of PV cells and panels, has grown considerably over the past decade. Roughly 50% of the market share comes from Chinese companies and four of the top five solar panel manufacturers are Chinese (Solar Love 2013). Their goal is to bring capacity to 35 Gigawatts (GW) by the end of 2015 or about 10 GW per year (Wall Street Journal 2013). Capacity refers to the maximum generation level to the best scenario in a given hour. Although the industry has made significant gains, falling prices, decreased demand from the E.U. and international trade conflicts are causing the industry to consolidate (New York Times 2014a). As a result of an anti-dumping investigation by the U.S., heavy tariffs have been levied on Chinese-made solar cells and panels. The U.S. Commerce Department announced anti-dumping tariffs of "26.71 percent to 78.42 percent on Chinese made solar panels, and rates of 11.45 percent to

27.55 percent on imports of solar cells made in Taiwan. In addition, the Commerce Department announced anti-subsidy tariffs of 27.64 percent to 49.79 percent for Chinese solar panels" (NYT2014b). Rather than levying tariffs, the E.U. has put import quotas and a price floor of \$.74/kW on Chinese made solar cells and panels (Business Today 2014). Because of the tariffs and quotas, the demand for Chinese panels has been reduced greatly in the international market, and Chinese manufacturers must rely on their domestic market to survive (Reuters 2013).

To survive in a competitive industry, Chinese PV manufacturers need to scan the internal and external environment. If they are to remain profitable, they have to develop strategies to significantly reduce overcapacity. It is also necessary for manufacturers to build up a domestic consumer base, as their previous markets in the U.S. and Europe are shrinking. As a pilot study, this research investigated: 1) the general issues influencing the success of the firms in the PV industry; 2) the current market channels and advertising methods; 3) the comparison of supports between desired and perceived from government and utility; 4) the attitude of manufacturers towards external opportunity and threats; 5) the operational issues. This is the first research endeavoring to understand the industry from manufacturers' side.

In order to aid manufacturers to improve the overall performance of their company through innovation, marketing and operations efforts, an understanding of the Chinese PCV industry will be helpful. The government must design and implement the appropriate policies to aid the development of the free market, and utility companies must initiate collaborative programs, which eventually lead to healthy growth and further development of the industry. This paper is organized as follows: Section 2 briefly reviews the academic papers relevant to this research, followed by the discussion of the survey method and structure in section 3. Section 4 discusses the major findings through the survey. Section 5 concludes the study with the implications and limitations of this paper.

Literature Review

There is a large body of research about PV industry from global perspective (IEA, 2014) as well as from individual country perspective (Zhao, Zhang, Hubbard and Yao 2012). Based on the focus of this paper, academic papers with a specific focus on the Chinese PV industry from the perspective of technological innovation and policy incentive are relevant. There are several papers which discuss the technological innovation in China's PV industry. De La Tour, Glachant, and Ménière (2011) examined PV innovations from other countries applied in the Chinese PV industry. The emphasis was on

patent information on Chinese PV manufacturers and the rate at which PV manufacturing was improving in China. Zheng and Kammen (2014) discussed Research & Development (R&D) investments as well as the impact R&D has had on the falling price of PV panels over the past decade.

There are several papers that explored the PV industry from a policy perspective (Zhao and Zuo, 2011, Rigter and Vidican 2010, and Zhi, Sun, Li, Xu & Su, 2014). Policies include subsidies, tax incentives, and feed-in tariffs, as well as international trade laws and demand side policy geared toward boosting the domestic market for Chinese PV. In order to examine the relative effectiveness of state and local policy tools in stimulating solar PV installations, Li and Yi (2014) applied a regression model on a database from 186 U.S. cities. According to their findings, cities implementing local financial incentives have 69% more solar PV capacities than cities that do not have such policies. Additionally, cities subject to Renewable Portfolio Standards (RPS) requirements have 295% more solar PV capacity than those not regulated.

There are two papers which are directly relevant to our paper and have a similar focus on China's PV industry. Zhao, Zhang, Hubbard and Yao (2012) examined the PV manufacturing industry in China as it relates to silicon prices and the cost of assembly of solar cells. Tax incentives and policy in regards to manufacturing are the major focus in this paper. Sun, Zhi, Wang, Qiang and Su (2014) examined the current issues in China's PV industry such as overcapacity, overly rapid market expansion, and the lack of confidence from financial institutes. They recommended remedies for some of the issues mentioned above, such as issuing relevant policies, pursuing opportunities to expand the international market, facilitating grid integration, establishing a market access mechanism and a healthy and innovative financial system. To our knowledge, none of these researchers collected first hand data from manufacturers directly. Manufacturers' opinion and attitude are underrepresented. Therefore, the first hand data in this study contribute to the understanding of these manufacturers' current status, attitude and the future strategies.

Survey
The survey was handed out to manufacturers at the SNEC 2014 PV Expo. SNEC PV Expo was the largest expo in China, and a showcase for the majority of manufactures in PV industry. The expo had more than 1800 exhibits. A total of 83 samples were gathered randomly and among them, 72 were fully completed. The respondents were manufacturers of various components along the supply chain, predominantly panels, wafers, cells, batteries, and inverters, although the majority of the surveys, 48.6%, were completed by solar panel

manufacturers.

In order to better understand the manufacturers in China's PV industry, the survey included the following five sections: 1) the general issues influencing the success of the firms in the PV industry; 2) the current market channels and the advertising methods; 3) the comparison of supports from government and utility between desired and perceived; 4) the attitude of manufacturers towards external opportunity and threats; 5) the operational issues. This research applied the basic statistics methods with Excel to explore the overall status of the Chinese PV manufacturers.

Major Findings
Manufacturers' Concerns in General
The first portion of the survey asked manufacturers to rank which components are most important to their success in the solar industry. The components, listed as choices, included not only marketing, operations and finance, which are the three major functions in any business (Heizer, 2012), but also human resources and innovation, which are specific issues in the PV industry. Because of the increasing cost of labor, hiring skilled labor is a major issue in many of China's industries. Additionally, the low efficiency of converting sunlight to electricity is a primary concern for larger adoption. Therefore, this aspect of innovation is important to investigate.

The first part of the survey asked manufacturers to rate components based on one to five scales, where five is the most important and one is the least important. Innovation received the highest score at 3.61, followed by the three major functions: marketing 3.45, operations 2.98, and finance 2.58. The option of human resources only scored an average of 2.33, which is the least important for success.

As the survey data indicated, innovation is critical to the survival and prosperity of the solar PV industry. Improvement in the efficiency of solar PV panel determines the future market shares for the firms in this industry; therefore large investments in innovation is essential. Marketing and operations are also important. The study further investigated the potential problems in these two fields. Although most literature mentioned the current challenges with financing for the manufacturers in PV industry (Zhao and Zuo, 2011), the results here did not get the same consent. The data shows that human resources is not major concern for Chinese PV industry. However with the concerns about innovation, the investment in human resource capital will become a larger issue.

Marketing
The second part of the survey examined manufacturers' products, customers, and methods of advertisement. It was

no surprise that solar panels were the most popular product manufactured. Among the valid surveys, thirty-five firms indicated that they are solar panel manufacturers. Nineteen of the firms answered yes to making other components, including brackets and mounts etc., which were relatively popular products at the expo. The third most popular product among our survey respondent were batteries. Fifteen firms answered yes to making batteries. While innovation has created batteries that store more energy, fierce competition is putting a downward pressure on prices, similar to what is occurring in the solar industry.

For the manufacturers we investigated, the major consumers are overseas, demonstrated by the thirty-five firms who stated that most of their products are exports. This is in line with the industry, as Chinese manufacturers have increased their international market share of solar panels over the past decade. According to twenty-four firms, the construction sector has been the second largest consumer, and residential is the third largest, according to twenty-two firms.

In terms of the marketing channels and advertising methods which these manufacturers currently use, the manufacturers can choose among eight options on the survey, including radio and television, newspaper ads, billboards, utility companies, email, social media, word of mouth, or other forms of advertisement. The results indicated the most popular form of advertisement was newspapers, which nearly half of the manufacturers used. After newspapers, emails and "other" forms of advertisement were the second most popular, selected by twenty-nine manufacturers. The manufacturers mentioned that other forms of advertising include expo and trade shows. The least popular form of advertising was through the utility (nine), which demonstrated a lack of collaboration. Word of mouth and TV/Radio advertising tied for the second least, with only sixteen manufacturers using each method.

From the results, we have determined that the traditional method of advertising in newspapers is still the dominant method, while using email to advertise is also becoming popular. Social media integrated advertising is still under development. Building strategic alliances and collaborating with the utility to promote PV products will be a new way of marketing in this industry, and will be detailed in the next section.

Supports from government and utility companies

The third part of the survey was designated to identify the gap between manufacturers' expected support and perceived support received from central government, local and provincial government, and the utility. Various forms of support are listed, including technical support, tax exemptions or rebates, subsidies, funding, or other forms of support. Their choices regarding collaboration with the utility consists of long term contracts, short term contracts, strategic alliance, one-to-one contracts, and other types of support. From the central government, thirty-four manufacturers mentioned that they received subsidies, twenty-six received tax breaks, twenty-five received funding, eight received technical support and seven received some other type of support. The most desired support that manufacturers wished to receive was in the form of subsidies, where thirty-six answered yes to desiring more support. Following subsidies were funding and tax breaks, where twenty-seven manufacturers desired more support from both. Twenty-six would like to see more technical support and four would like to see more of other types of support. The biggest difference between the support they received and the support that they would like to receive was technical support, where eighteen manufacturers would like to receive more support than they are currently receiving. Two manufacturers would like to receive more support from subsidies as well as more support from government funding. Only one additional firm would like to see more tax breaks.

From the provincial government, thirty manufacturers agreed upon receiving subsidies. Twenty-three answered yes to receiving tax breaks as well and another twenty-three to receiving funding. Twenty-three answered yes to receiving technical support and six answered yes to receiving some other type of support. The most desired support came in the form of subsidies, where thirty answered yes to receiving, followed by funding at twenty-three, technical support at eleven, tax breaks at twenty-three, and other forms of support, where six firms answered yes to receiving support. The difference between support that manufacturers expect and what they receive deviates more when dealing with provincial government than with the central government. The largest difference was still in the form of technical support at 21.1%, followed by funding at 11.3%, and subsidies at 9.9%. There was no change in support from tax breaks and other desired support by 1.4%.

When it comes to receiving support from the utility, 35.2% receive support with some form of strategic alliance, 23.9% receive support from long-term contracts, 19.7% receive support in the form of promotions, 15.5% receive support from short-term contracts and 9.9% receive other types of support from the utility. Strategic alliances and long-term contracts are both the most desired support at 39.4%, followed by promotions at 18.3%, other forms of support at 12.7% and short-term contracts at 5.6%. The largest difference between support and desired support from the utility is in the form of long-term contracts, where 15.5% more firms answered yes to desiring more long-term contracts. What is also interesting

to note is that 9.9% less firms would like to receive support in the form of short-term contracts and 1.4% less would like to receive support in the form of promotions from the utility. This suggests that promotions from the utility along with short-term contracts are making it harder for manufacturers to remain profitable. As far as support in the form of a strategic alliance, 4.2% more would like strategic support but not in the form of promotions and not in short-term contracts.

We also asked manufacturers to explain the biggest challenge that they face when doing business with the utility. Within twenty-six responses, 34.6% explained that the bureaucracy is the largest issue, 30.8% had issues with receiving payments in time to maintain cash flow from the utility, 26.9% had issues with getting solar tied into the grid, 7.7% had issues with the utility adopting solar technology.

Manufacturers' Opinion
The fourth part of the survey had 11 questions pertaining to the attitude of manufacturers towards the external opportunities and threats. They were based on the following factors: 1) socioeconomic conditions of Chinese consumers; 2) the influence of labor cost and silicon prices based on manufacturer's revenues; 3) the changes of Chinese, European, and American electric rates; 4) environmental and government policies. Using a 1 to 5 Likert scale, the survey gauges how strongly manufacturers agree or disagree with a series of statements designed to investigate manufacturers' opinions and attitudes towards the issues mentioned above.

The first two statements address the ways in which the increasing population and an emerging middle class are helping to create more sales. The average score were 3.17 and 3.56, which indicates neither strongly agree nor strongly disagree. The next four statements asked about environmental cleanup as well as statements from government and utility policy. The statement on environmental cleanup had an average of 3.0 while the statement concerning the ways in which environmental regulations hurt businesses scored an average of 3.16. The statements focusing on central, local and utility policies had averages of 3.34, 3.33, and 3.06 respectively. Obviously, manufacturers showed neither strong agreement nor disagreement.

The last three statements regard the influence of raw material costs, as well as local and international electric rates, on sales in the industry. The statement concerned with the manner in which falling prices of silicon are decreasing revenue scored a 3.69 as an average. Increasing electric rates in China that are helping sales scored an average of 3.61 while the increasing electric rates in the US and EU scored an average of 3.49.

As demonstrated by the results of the survey, manufacturers' opinions lean towards agreement with the above factors affecting the financial status of the firms.

Operational issues
The fifth part of the survey asked manufacturers detailed questions from the operations' perspective. The questions included challenges the manufacturers faced, their largest expenses, quality control methods, and the ways in which manufacturers' work to increase efficiency. As to the challenges that manufacturers are facing, twenty-eight manufactures agreed that uncertain demand is the biggest challenge, while twenty-seven others chose large purchasing costs. In regard to the largest operating expense, forty-one chose purchasing cost. This surpassed labor cost with twenty-six and R&D with twenty. Only six manufacturers agreed that large inventory levels were their greatest challenge, followed by three choosing stock outs. Thirteen manufacturers believed that transportation cost is the largest expense. With eight, the second largest is advertising cost. Based on the response from fifty-four firms, the average lead time is 18 days. Here, lead time referred to the time length between order placement and shipping. Normally, the lead time indicates the time between order placement and receipt; however many people who responded to the survey indicated that lead time to the U.S. and Europe was as little as a week. When questioned further, they explained that it can take up to three weeks for the panels to arrive from China.

Conclusion and limitations
Based on the results above, China PV manufacturers indicate that innovation is the largest factor determining their success. Targeting the largest investment toward technical innovation has been the pattern in the last few years and will continue to be the general trend in the future. Manufacturers still need to improve targeted areas of their operations, including forecasting and marketing. Many PV manufacturers do not have an accurate method to forecast future demand and this resulted in an overproduction of PV panels over the last couple of years. Better forecasting would prevent manufacturers from overproduction, and would avert the need to sell off large amounts of inventory at a significant loss. Manufacturers need to invest more of their marketing energy into researching and implementing advertising methods more efficient at reaching potential consumers. The two major methods of marketing by PV manufacturers are through newspapers and mass emails; although newspaper subscriptions are increasing in China (Hook, 2013), mass emails have a response rate of .12% (Marketing Charts, 2013).

Survey data indicated that PV firms in this industry widely

received support from central government and local government. Although data did not show a significant gap between what manufacturers received and what they desired for various form of support, technical support from the government is manufacturers' strongest desired support. As for the PV industry as a whole, there are four recommendations that the government could implement in order to improve the PV manufacturing industry. First, improve the domestic market through demand side subsidies. Consistent feed-in tariffs and distributed generation subsidies will incentivize investment in utility sized PV systems by the residential sector. Second, explore as potential new markets the developing countries in Africa and Latin America. They stand to benefit from cheap PV technology by using it as a more consistent way to spur economic growth. Third, improve the financing mechanisms that are used to fund PV technology and assure the financing is consistent, which would make manufacturers less hesitant to invest in R&D or improve the manufacturing process. Fourth, the creation of a central agency within the government that handles only the issues relating to the PV industry so manufacturers and developers only need approval from one agency.

The collaboration with and the support from utility companies are really under development. As indicated by the results, the utility could play an important role in aiding PV manufacturers by streamlining the grid tie-in process. The slow process of permitting, connecting to the grid, and making payments is posing a threat to the economic viability of many PV manufacturing firms. Furthermore, the utility must become more consistent with payments disbursed to the manufacturers, as late payments can and does hurt the finances of PV manufacturers.

Collecting first hand data directly from these manufacturers during the expo made it possible for this study to understand and learn from this industry. However, this research is also limited by this method of collecting the data. First of all, the response rate is still very low. Most manufacturers refused to answer the questions. Therefore, the results from seventy-two manufacturers may not generalize the whole industry. If manufacturers are producing different components in this value chain, they would face different challenges and opportunities. Secondly, most participants for this survey were salespersons; therefore the survey distributed directly to the operations managers or the higher level managers of the companies might provide more accurate information for us to understand the questions relevant to operations. Lastly, this study is also limited to one country - China. It would be interesting to compare manufacturers from different countries. All the limitations discussed above provide future research

with a direction to in order to help researchers understand this industry.

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About the Authors

Patrick Prince is a senior, studying Operations Management and Economics. Prior to conducting this research, he completed internships for New England Solar Hot Water and "Rate it Green." He currently works for Associated Energy Developers as a financial analyst for renewable energy projects, including wind and solar. Bingqing Zheng is a junior, majoring in Operations Management with a minor in Actuarial Science. Under the direction of Dr. Xiangrong Liu (Management), this joint research project included 21 days of fieldwork in China in summer 2014. Their travel and research were funded by BSU's Undergraduate Research Abroad grant, with the support of the Office of Undergraduate Research and the Dr. Edward W. Minnock Center for International Engagement. Patrick and Bingqing presented this research at the 2015 National Conference on Undergraduate Research in Spokane, Washington.

Examining College Students' Knowledge of and Attitudes Toward PV Power Systems in Major Cities in China

Steven Spicer & Yaqin Sun

Introduction

Photovoltaic (PV) power generation is a rapidly expanding source of electricity. PV generation, originally invented to fuel space-bound aircrafts (Knier, 2002), is now a viable alternative to traditional fossil fuels. With rising environmental concerns and the increasing cost of conventional fuel sources, countries are more invested than ever in PV generation (Renewable Energy Policy Network for the 21st Century, 2014).

Background of Photovoltaics

In 1922 Albert Einstein was awarded the Nobel Prize for his work and papers exploring the photoelectric effect. The photoelectric effect refers to the electric current produced when certain materials, called photons, are exposed to light (Knier, 2002). Solar PV panels use the photoelectric effect to directly convert the sun's light energy into usable electricity. Panels or modules consist of an array of cells, each of which generates an electric current when exposed to light. Panels are rated by output stated in watts. In cell manufacturing, the wattage of a system is dependent on the number of solar cells present (size of panel), the semiconductor material used (primarily silicone) and the quality of said material. The geographic location of installation, weather, as well as installation parameters also affect the output of the solar module.

Global Photovoltaic Market

In 2013, following a record addition of 36.9GW, the installed capacity for PV power generation was 136GW globally. Germany, the world's largest producer with 35.5GW installed PV capacity, nearly doubled China's 18.3GW, which represented the second largest contribution. Italy, Japan and the United States rounded out the top five with 17.6GW, 13.6GW, and 12.0GW respectively (International Energy Agency, 2014).

The Trade War

In 2012, Chinese firms manufactured roughly 2/3rds of the global PV modules that reached market (Renewable Energy Policy Network for the 21st Century, 2014). After struggling to compete with low Chinese prices, PV panel manufacturers in the US and Europe claimed foul play, stating Chinese firms were unfairly selling panels below costs, or dumping products internationally. EU Prosun, an industry association for European solar PV manufacturers, filed a suit with the World Trade Organization in July of 2012 (Clean Technica, 2012). Dumping allegations are explained below.

The European Commission, on behalf of the European Union and the World Trade Organization, conducted an anti-dumping investigation of Chinese manufactured panels exported to the European Union from 2011-2012. Case AD590 concluded with the EC imposing anti-dumping taxes on Chinese imports to Europe (European Commission, 2013). The US International Trade Commission published similar findings in 2011, stating that Chinese module manufacturers were exporting panels at less than fair value (LTFV). The US ITC penalized the Chinese manufacturers and imposed increased tariffs on Chinese imported panels (U.S. International Trade Commission, 2011). Australia also launched an investigation into the 'dumping' of Chinese panels in 2013 (Hannam, 2014). As a result, all Chinese made PV modules and components imported into the European Union are subject to an average anti-dumping duty of 47.6%. The tariff is in effect until at least 2018 (European Commission, 2013). Chinese and Taiwanese solar modules and components exported to the US are also subject to sanctioned duties, ranging from 26% to 165% (Roselund, 2014)

Following dumping investigations and repercussions, China observed an 18% decrease in PV panel exports, including a 62% decrease to European markets (Clover, 2014). Additional sanctions from trade organizations limit exporting potential for Chinese PV panel manufacturers. China's manufacturing levels, dependent on foreign markets, were far greater than the domestic need. In 2013 China observed a 20% decline in the export value of PV modules and components (Fang, Honghua, & Sicheng, National Survey Report of PV Power Applications in China, 2013). China will need to develop its domestic PV market in order to reduce the excess inventory.

The Development of Chinese Domestic PV Market

China ranked first amongst all nations in total carbon dioxide emissions in 2013, emitting 29% of the global total. Furthermore, studies suggest China's coal-fired power plants account for 75% of the emissions (Oliver, Janssens-Maenhout, Muntean, & Peters, 2014). The pollutants and soot in China's atmosphere have been linked to 1.2 million deaths a year (Nijhuis, 2014). Serious pollution is a strong reason in support of China's goal to increase PV generation domestically.

Reflecting the growth of recent years, China is now the world's second largest producer of PV power with 18.3GW, a number that reflects less than 1% of China's total electricity demand (Renewable Energy Policy Network for the 21st Century, 2014).

China's 12th 5-year plan, released in 2011, stated goals for installed PV capacity of 21 GW by 2015 and 50 GW by 2020 (Qiang, Honghang, Yanxi, Yurui, & Jun, 2014). To achieve this goal, China must gain the support of private investors to purchase, own and operate grid connected PV power systems. Prior to the most recent 5-year plan, China began incentivizing PV adoption as early as 1999 during the 10th 5-year plan. The Brightness Rural Electrification Program, using PV and wind technology (National Renewable Energy Laboratory, 2004), sought to provide power to nearly 23 million people living in remote areas in Western China. Due to high solar radiation levels and barren desert landscapes, western China is suitable for solar power development, including the development of large scale utility-sized solar farms (Meisen & Hawkins, 2007). The capacity of the farms far surpasses the local need and could export power to the more populous and industrialized Eastern China. However, transmission is difficult in light of the extended distance; transportation and distribution losses would be prohibitively high. Therefore, current government incentive programs, such as the Golden Sun program, lean toward to the projects that are "self-generation, self-consumption" (Climate Connect, 2010). As a result, government incentive programs that support building integrated PV systems and building-attached PV systems, especially roof-top systems, are attracting increasing investment. After China's National Development and Reform Committee commenced the Feed-in-Tariff (FiT) subsidy policy for PV grid-tied applications in 2011, China observed a 400% increase in PV installations (Fang, Honghua, Sicheng, & Dou, National Survey Report of PV Power Applications in China, 2011). China's installed PV capacity nearly doubled in 2012 from 3.5MW (2011) to 6.7MW. In 2013, following an increased subsidy shifting the FiT from .8/kWh to 1.5/kWh, PV installations rose 306% (Fang, Honghua, & Sicheng, 2013).

To test the future success of incentive programs and the PV industry as whole, college students at two of China's prominent universities were surveyed. According to UNESCO, "education will shape the world of tomorrow [and] is the most effective means that society possesses for confronting the challenges of the future" (UNESCO, 2002). With this ideology in mind, college educated students serve as the most likely adopters of PV technology and represent the force attempting to change the current environmental situation in China. Following years of education in science, and likely an education in sustainability,

clean energy and renewable energy are not new concepts to most college students. Therefore, students' attitudes towards the PV power industry shed light on the future of China's domestic PV market. Higher education levels indicate higher receptiveness to PV adoption (Schelly, 2010). Although most college students do not possess property or earn high salaries while in school, according to a 2011 poll Chinese college graduates earn a starting salary of 30,000 yuan a year, making it possible for young graduates to invest in a PV system (People's Daily Online, 2011).

Based on the above introduction of photovoltaics, the global PV market, and China's domestic market, we will explore the potential market of Chinese college students. Section 2 will contain a brief literature review. Section 3 discusses the methodology and is followed by a survey data examination in Section 4. Conclusions drawn from observations and suggestions to increase customer adoption of PVS are found in Section 5. We address any limitations and possible future studies in the Section 6.

Literature Review
For an overview of the history, status quo and projection of PV industry in China, readers may want to refer to Zhao et al. (2011), (Zhao, Shi, Chen, Ren, & Finlow, 2011), Fang et al.(2012) (Fang, Honghua, & Sicheng, National Survey Report of PV Power Applications in China, 2013) and Sun et al. (2014) (Sun, Zhi, Yao, & Su, 2014) for detailed information. Historically, academic papers have focused on the public policy instruments used to increase PVS adoption. The incentives fall into two trains of thought: technology-push methods, where the government subsidizes manufacturing, technology creation and innovation; or demand-push policies issued by government to generate a demand within the market (Qiang, Honghang, Yanxi, Yurui, & Jun, 2014). Feed-in-tarriffs (FiTs) are an example of a widely used demand push-instrument which has been implented in several nations, including China. PVS operators are paided a subsidy for surplus electricity generated exceeding their individual consumption, or electricity that is 'fed-in' to the grid.

Beyond the discussion relevant to policy, there are several papers analyzing the benefits derived from PV generation, both financial, and environmental, and the influence of those benefits on demand. Pillai et al. (2014) (Pillai, Putrus, Georgitsioti, & Pearsall, 2014) created a metric; prosumer (a producer and consumer of PV power), electricity unit cost (PEUC), to examine near term economic benefits generated from solar PV systems. The study concluded that with FIT and low interest loans, PV owners observed a faster ROI.

Li et al. (2007) provided a good summary for building-integrated solar energy adoption. Social interaction and acceptance has been explicitly mentioned as one of the three factors influencing the solar industry's development along with policy-oriented market and subsidies. Our research focuses on studying this social interaction and acceptance.

Labay and Kinnear (1981) classified adopters and non-adopters of solar energy systems based on demographic and attribute perceptions of the PVS. Kaplan's (1999) technical knowledge, motivation, experiences and familiarity are four critical influences on interest in PV. Under the framework of Diffusion of Innovation, Faiers and Neame (2006) compared a group of 'early adopters' and 'early majority' regarding attitudes towards domestic solar power systems. However, they did not specify the type of solar application.

Schedlly's (2010) paper tests the relationship between residential solar thermal adoption at the county level and three indices by using a logistic regression model. The three indices include a socioeconomic index, an environmental concern index and an environmental index using public data. The paper concluded that counties with higher education levels, less unemployment, and higher levels of disposable or investment income, indicated higher interest in adopting solar thermal technology.

Chen's (2014) study investigated a framework between value, life-style, personality, and environmental behavior intention related to solar power systems. Chen used 203 college students and faculty at a university in Taiwan to test against the structural equation modeling. Chen identified college students as "leading crusaders in the modern environmental movement." Chen and Su (2014) define a strategic consumer as a consumer who waits to purchase an item at a discount, typically following the introduction of a newer replacement product. The impact of their decision on the supply chain performance under a revenue sharing coordination mechanism is explained.

Despite the vast collection of academic papers on PVS, there are few papers that explore the knowledge and views of potential PV customers in China. Therefore, in this pilot study, using a collection of college students as the sample population, we will use the survey data to reflect the current problems of adopting PV so that we can offer suggestions to government, industry and higher education systems.

Methodology and Survey Design
For reasons of accessibility, this survey utilized a convenience sampling method rather than a representative sampling method. Primary data collection was conducted during a 21-day field research trip to Beijing Jiaotong University and Shanghai Normal

University in China during the summer of 2014. According to the 2012 China University Rankings (Junmian, 2011), both schools are found on the list of the top 100 universities in China. Beijing and Shanghai are the largest cities in China with slightly over 40 million inhabitants combined (UN New York, 2014). Beijing is the capital of China, and Shanghai serves as an important financial center and business hub. The high civilization status and fast economic development generates a high energy demand, which contributes to a larger potential market for PV residential adoption. Shanghai and Beijing are also on the forefront of higher education in China, with more than 100 public or private universities.

Out of 328 issued to students at the two universities, 275 valid surveys were collected. The survey was carried out during the lecture portion of several classes. All of the surveys were completed in English. As some students lacked fluency in English, only 275 questionnaires were valid. The whole study is based on the 275 questionnaires and to some extent, this survey serves to represent the average college students' knowledge of and common attitude towards PV adoption. Students were asked to complete a 4-page survey designed to evaluate their knowledge of, and potential purchasing behavior for, PV technologies.

A brief introduction of solar PV systems was given in order to clarify the definition and domain of the survey questions. Detailed technology principles, measurements and economic benefits were not discussed in order to avoid potential bias given by the survey administer. The survey consisted of 27 questions on 4 pages, and included a wealth of information. The survey can be divided into five sections: major societal concerns, prior experience with PV systems, attitude towards PV adoption, knowledge of PV systems and demographic questions.

Most questions were designed with a five-point Likert scale. In the first section of the survey, students ranked major concern among several possible categories: Employment, Energy, Safety, Quality of Life, and Education, and followed by ranking sub-issues within each category. The second portion of the survey was designed to measure prior experience with solar technology with a focus on the PV system. Questions were geared towards usage, observed locations of PV systems, advertisement methods, etc. In the third section of the survey, four questions were posed to gauge the students' technical knowledge of PV panels. Students were asked to rank government incentives and actions, possible and actual, required to increase private PV investment. The fourth section of the survey focused on students' attitude towards PV system adoption, such as the desire to purchase, potential motivations

Table 1.1 College Students Surveyed by Major

Major	Frequency	Percentage of Sample Group (%)
Economics	84	30.55
Engineering	64	23.27
Traffic and Transportatiom	32	11.64
Statistics	18	6.55
Automation	9	3.27
Finance	9	3.27
Science	9	3.27
Computer Science	8	2.91
Communication	7	2.55
Undecided/Did Not Answer	9	3.27
Tax	5	1.82
English	3	1.09
Other*	18	6.55
Total	**275**	**100.00**

*All majors with less than 1% of the sample population including: Clean Energy, Enterprise Management, International Trade, Logistics, Advertisement, Business, Math, MIS, and Wind Power

Table 1.2 College Students Surveyed by Province/SAR

Province/SAR	Frequency	Percentage (%)
Anhui	22	8
Beijing	19	7
Fujian	9	3
Gansu	6	2
Guangdong	4	1
Guangxi	4	1
Guizhou	3	1
Hezbei	25	9
Heilonhjiang	3	1
Henan	12	4
Hinjiang	1	0
Hubei	4	1
Hunan	7	3
Inner Mongolia	3	1
Jiang Su	11	4
Jiangxi	4	1
Jilin	5	2
Korea	2	1
Liaoning	9	3
Ningxia	3	1
Shandong	29	11
Shanghai	49	18
Shanxi	11	4
Sichuan	6	2
Tianjin	1	0
Undeclared	9	3
Xinjiang	3	1
Yunnan	2	1
Zhejiang	9	3
Total	**275**	**100**

and barriers that might deter purchase. The last section of the survey identified students' demographic information. Based on the answers to the demographic questions, 55.6% of students surveyed identified female and 43.6% identified male. 69.3% of the students were undergraduate students and 29.6% were in a graduate-level program. Economics, engineering, and traffic and transportation majors were most prominent with 33.6%, 20.4% and 10.8% respectively. For a complete breakdown of students by majors, refer to Table 1.1, 27 different Chinese provinces and Semi-Autonomous Regions were represented in the sample group. 19.6% of the students surveyed originated in Shanghai, followed by Shandong and Anhui with 10.4% and 8.4% respectively. 7.6% of the sample group was from Beijing. Table 1.2 provides a breakdown by Province/S.A.R.

Data Examination
Major Concerns in General
In order to rank social, political and environment concerns, students were asked to select from a 5-point scale, where 5 represented the most pressing issue/concern while 1 represented the least. Students indicated a higher level of concern for issues of public safety than with issues of employment, energy, quality of life or education. Public safety averaged 3.78 out of 5; quality of life was the second highest rank with a score of 3.58; education scored 2.84; energy and employment are the lowest two with 2.48 and 2.47 respectively.

Energy issues have not been reported as the greatest concern for college students. The lack of concern may be explained by the low cost of utilities in China, and may also predict the potential difficulty of PV adoption among residents. Meanwhile, public safety and quality of life are of the highest concern for students, which indicates a high potential for adoption of PV system because of the ecological benefits a solar PV system generates.

Within the issues of public safety, students indicated the greatest level of concern for food safety with a threat index of 3.72 out of 5, followed by health issues resulting from pollution with a score of 3.31. According to previous data

(Nijhuis, 2014), roughly 1.2 million deaths a year are attributed to pollutants and soot produced by China's coal-fired power plants. The leading issue in the energy sector was pollution from conventional energy sources, with a threat index of 3.06 out of 4. The cost of living and a lack of personal freedoms were the two most pressing issues in quality of life, with average scores of 2.74 and 2.69 out of 4 respectively.

In the education sector, students indicated their greatest concern was the quality of education, scoring 4.08 out of 5.0 on the previously mentioned 5-point-scale. Fear of education lacking innovation also scored high (3.51). Focusing on renewables and sustainable practices, only 14% of the surveyed students had ever been taught sustainability principles. This score is far too low for a country actively seeking to increase the demand for PV technologies and generation.

Prior Experience with Solar Technology

Before examining the use of and purchasing desire for PV, it is important to have context. For a comparison, students were asked similar questions for both solar PV and solar water heating systems. 50% of students surveyed indicated no knowledge of PV technologies, a number ten times greater than the 4.8% of students who were unaware of solar water heating systems. 77.6% of students had used a solar water heater, while 10% had used solar PV. Less than 20% of students (18.4%) indicated a future desire to purchase a solar PV system. 3.2% indicated a prior purchase of solar PV technologies. This wanes in comparison to the same question posed with solar water heaters; 58.4% reported prior purchase and 26.8% indicated a future desire to purchase.

Students were asked to note which solar PV installations they have observed. 61.2% observed residential applications of PV technologies, 30% observed PV technologies in a solar farm application, 43.3% reported seeing solar PV technologies on commercial buildings and 47.6% noted application of PV technologies on government buildings. Investment in solar water heaters is and will be far more prevalent than PV technology, yet an increase in government participation with PV will increase awareness amongst potential customers, and may possibly increase participation rates.

Students were asked questions to test receptiveness to and awareness of PV technology marketing. Television advertisements for PV panels were most commonly observed, with 78% of students indicating they have observed PV systems advertised in television ads. Other common advertisement medians included the internet and Weibo (a popular social media site), with observation rates of PV advertisement of 69.6% and 38.4% respectively. 67.6% of students surveyed

selected television as a reliable source of data, Internet was selected by 42% and recommendations from friends, family, and peers was selected by 38% of students as a reliable source.

Knowledge of PV systems

Narrowing the focus on PV knowledge, students were asked 4 questions on the specifics of PV technologies. Students were asked to choose a realistic time period to recoup investment cost (typical ROI), select an efficiency range for PV panels, and answer two basic dichotomous questions. Answers were either marked reasonable or unreasonable. 19% of students were unaware that solar power is a renewable energy source. Roughly half (56%) gave reasonable answers for average panel efficiency answering either 0-25% efficiency or 26-50% efficiency. 77% of the students gave reasonable answers for average ROI with 43.6% choosing 2-6 years and 34.8% selecting 7-12 years. 80% of students were aware of government-funded financial incentives to purchase PV technologies, which indicates that an increase in education for sustainable practices and green technology would create a more interested and educated target market.

Attitude towards PV System Adoption

A high initial investment cost for PV systems was most frequently selected as a barrier preventing adoption, endorsed by a 64% sample set. Peoples' attitude and lack of concern for the environment, followed by inadequate technology, ranked second and third as barriers preventing growth, with 43.6% and 42.8% of the sample population endorsing the reasons.

Students were asked to rank several strategies to increase customer participation with solar PV, on a scale of 1-5 with 1 being the least effective and 5 being the most effective. Possible answers included: cash discount on the PV system price, a discounted electricity rate for PV producers connected to the grid, low interest loans to assist with project cost, or a restriction on conventional energy sources. A sanctioned restriction of fossil fuel imposed on utility companies was the highest ranked with a 2.71. Low interest loans to help negate the high initial investment cost ranked closely behind with a score of 2.55. Thirty-eight perecent (38%) of students strongly agreed, and 20% agreed, that investing in solar PV technology will have an effect on improving the environmental situation.; and, 69.6% of students were optimistic about the growth of the PV industry and the growth of the adaptation of PVS for residential installations in China.

Conclusions

This study offers the first look at the knowledge of students and their attitude towards PV adoption on the roof top. China's college students serve as a potential market for solar

PV systems in the next five years. The study results indicate that college students currently do not prioritize energy as an issue directly related to safety and quality of life. However, the results also clearly demonstrate that the emphasis on pollution issues will lead this generation to consider renewable and clean energy as an alternatives to conventional energy.

On one hand, the results show that there is a limited percentage of college students who are aware of PV adoption, especially when compared with awareness of other solar energy applications, such as solar water heater. On the other hand, given the evidence presented from these results, students do not possess sufficient knowledge of solar PV technology. The inclusion of topics of sustainability in the public and collegiate education agenda is one possible solution to this shortcoming.

Based on the discussion above, the results suggest the importance of advertisements and effective communication among government, the PV industry and potential customers. Traditional methods of promoting PV systems, such as television, are dominant. However, there are other media avenues more accessible and interactive to the young generation (college students), and exploration and utilization of alternative channels is crucial. Although the government provides support to the industry and the customer, additional demonstration projects could be established to increase visibility.

Overall, the majority of students believed, despite their sensitivity to the initial investment of the products, that the future PV market is promising. With significant advancement of technology and continuous cost reduction, PV rooftop systems will be popular among young families in China in the next few years.

However, limited by the accessibility of the data, this research included some bias. The sampling method implemented was a convenience sampling taken from only two schools. Additional research based on a larger population, using well-designed sampling methodology, could better identify social acceptance among young, future customers. However, this pilot study can provide direction in order to gauge and analyze the attitude

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About the Authors

Steven Spicer is a graduating senior majoring in Management. This research project was completed during the summer and fall of 2014 under the direction of Dr. Xiangrong Liu (Management) and made possible with funding provided by the Adrian Tinsley Program Undergraduate Research Abroad Grant. He is grateful for his research team members, Yaqin Sun, Patrick Price, and Bingqing Zheng and the leadership of Dr. Liu. He also thanks his loving family and friends who've supported his ambitions. Yaqin Sun is a senior majoring in Mathematics. Yaqin is from Nanchang, Jiangxi, a southern city in China; this is her fourth year in the U.S. This experience not only strengthened her research skills, but also helped her decide her professional future. After graduating, Yaqin will pursue a PhD in the field of decision science. She is very appreciative for the mentorship given by her mentor and the encouragement given by her teammates.

Phone Selection through Data Envelopment Analysis

Elissa Turpin & Adam Sanchez

Introduction

The advances in smartphone technology are making phones the most popular "smart" devices among technology consumers today. A smartphone is a mobile device that allows users to make calls as well as perform actions such as sending email, managing information, and using calendar and planning functions of a PDA (personal digital assistant) or personal computer. In 2013, 14% of the global population used smartphones; in the United States, that number was 37%. With all of the new innovations in the smartphone market, that 37% is expected to rise to 59% in the United States by 2016 (CMO Council, 2012).

As the smartphone market grows and competition increases, it is imperative for smartphone manufacturers to maintain or improve the level of satisfaction among customers during the phone selection process. Smartphone competition in the United States is fierce as a result of easy access to technology, as well as events such as the legal feud between Apple and Samsung. Smartphone makers in the United States are constantly competing to create the next best phone in order to entice consumers and increase market shares. In order to take advantage of the intense competition and variety of features, it is important for potential buyers to conduct product comparisons before deciding upon which phone to purchase. The purpose of this paper is to use Data Envelopment Analysis to determine, out of eight popular smartphones, which is the most efficient: (1) Apple iPhone 5, (2) HTC Windows Phone 8s, (3) HTC Desire, (4) Samsung Galaxy S4, (5) Samsung Galaxy S4 Mini, (6) Samsung Gusto 3, (7) LG Cosmos 3, and (8) Nokia Lumia 928. These eight phones have been the top choices by consumers in the past few years (Brian, 2012). Not only were they among the top grossing smartphones, but these eight were also selected based on the number of market shares in the United States. Although Apple and Samsung were the only two companies with market shares in the double digits, the other companies still hold a great deal of promise for benefiting the growing smartphone market.

Literature Review

Bayraktar, Tatoglu, Turkyilmaz, Delen, and Zaim (2014) found that customer satisfaction is an important aspect in the phone selection process because product enjoyment and satisfaction have a positive impact on phone selection. Their research reflected only one particular perspective of customer satisfaction, but satisfying a customer is complicated because it involves multiple dimensions of comparisons. For example, Khawand (2007) tested each smartphone on his own and then published a book based on his daily blog about his experience with each product. Khawand listed all of the pros and cons of each phone to help in order to share his knowledge of the products with consumers, but he did not conclude with which were the best. During the selection process, consumers can benefit from Khawand's hands-on experiment, using his feedback as a means of choosing a phone that will meet their specific needs. However, more comprehensive quantitative analyses, which compare the multi-dimensional data of the different smartphone features, are desirable.

Taking multi-dimensional data into consideration, the Analytic Hierarchy Process (AHP) has good potential to solve phone selection problems. The AHP provides a comprehensive and rational framework for structuring a decision problem for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions. All the dimensions for the alternatives need to be evaluated by customers objectively and integrated in order to obtain the "best" in the end. Tan and Mustafa (2006) compared 19 attributes (mobile phone options): dimensions, standby time, weight, talk time, memory, ROM, expansion slot, Wi-Fi, Infrared, Bluetooth Java application, MP3, messaging types, GPRS, WAP, camera resolution, color display, screen resolution, and price. They then used the AHP method to minimize the pool of attributes. To reflect the new features of cell phones, Falaki et al. (2010) employed the same method using only four attributes for comparison: user interactions, the use of the applications, network trafficking, and the amount of energy used.

Consumers are limited by the nature of the AHP method because it is very difficult, first, to weight each attribute of a product; then they would need to evaluate each attribute in relation to the same attribute in all of the alternative products. Another major method to handle multi-dimensional data, Data Envelopment Analysis (DEA), directly uses the quantitative data of various products and applies mathematical programming to calculate weights for each attribute. By calculating weights for each attribute, DEA clearly reflects the trade-offs among different attributes. DEA is a powerful quantitative, analytical tool for measuring and evaluating performance using a variety of criteria.

The DEA model offers wide applications in real-world

problems, such as determining the eco-efficiency of electric and electronic appliances (Barba-Gutiérrez, Adenso-Díaz, & Lozano, 2009). Our research applies the DEA approach in order to compare the purchasing efficiency of eight popular smartphones and determine the best among them. The purchasing efficiency refers to the ratio of all of the important attributes customers obtain from the smartphone (the outputs) in relation to the phone's cost to the consumer (the input).

Methodology

The methodology used to conduct this study is known as Data Envelopment Analysis (DEA). DEA is a non-parametric approach suggested by Charnes, Cooper, and Rhodes (1978). It is used to evaluate the performance of decision-making units (DMUs) where there are multiple inputs and outputs. All of the DMUs that are being evaluated are assumed to operate homogeneously, with an outcome known as an efficiency ratio. The measure of efficiency of a DMU is defined as the ratio of a weighted sum of outputs to a weighted sum of inputs. In this particular study the focus is on maximizing efficiency; therefore, the formula used is as follows:

Objective Function:

$$E_e = \frac{\sum_{i=1}^{M} u_i o_{ie}}{\sum_{j=1}^{N} v_j l_{je}} = \frac{u_1 O_{1e} + u_2 O_{2e} + .. + u_M O_{Me}}{v_1 I_{1e} + v_2 I_{2e} + .. + v_N I_{Ne}}$$

Subject To:

$$\frac{\sum_{m=1}^{M} u_m o_{mk}}{\sum_{n=1}^{N} v_n I_{nk}} = \frac{u_1 O_{1k} + u_2 O_{2k} + .. + u_M O_M}{v_1 I_{1k} + v_2 I_{2k} + .. + v_N I_{Nk}}$$

Symbol	Representing
Ee	Efficiency of the eth DMU
Oie	The ith output dimension for the eth DMU
ui	The weight for the ith output dimension
Ije	The jth input dimension for the eth DMU
Vj	The weight for the jth input dimension
Oik	The ith output dimension for the kth DMU
Ijk	The jth imput dimension for the kth DMU
i	The index for output dimension
j	The index for input dimension
e	The target DMU, e =1
k	The kth DMU, =1...K

To solve the formula using standard linear programming software, the ratio above must be restated as a linear function. And in order to restate the objective function as a linear function, the inputs for the DMU under evaluation must be scaled to a sum of 1.

Objective Function:

$$\text{Max } E_e = u_1 O_{1e} + u_2 O_{2e} + ... + u_M O_{Me}$$

Subject to:

$$v_1 I_{1e} + v_2 I_{2e} + ... v_N I_{Ne} = 1$$

For each DMU, the constraints are similarly reformulated:

$$(u_1 O_{1k} + u_2 O_{2k} + ... u_M O_{Mk}) - (v_1 I_{1k} + v_2 I_{2k} + ... v_N I_{Nk}) <= 0$$
$$k = 1, 2, ..., K$$

$$\text{Where: } u_j >= 0 \quad j = 1, 2, ..., M$$
$$v_i >= 0 \quad i = 1, 2, ..., N$$

Data Analysis

Eight types of smartphones were the decision-making units: (1) Apple iPhone5, (2) HTC Windows Phone 8s, (3) HTC Desire, (4) Samsung Galaxy S4, (5) Samsung Galaxy S4 Mini, (6) Samsung Gusto 3, (7) LG Cosmos 3, and (8) Nokia Lumia 928. There are many dimensions to look at when selecting a phone. For the DEA method, it is only possible to compare those variables that are quantitative. Therefore, the output variables chosen for this comparative study were weight (ounces), standby time (hours/unit), battery life (mAh), and camera resolution (megapixels). As for the inputs, the only variable chosen in this study was the retail price.

Weight, in ounces, is one of the quantitative measurements consumers find important when selecting a phone that meets their needs. Standby time, another output measure, is the officially quoted longest time (measured in hours) that a single battery charge will last when the phone is constantly connected to the GSM network but is not in active use. Standby time relates to the battery life of the phone, which consumers consider one of the most important characteristics when choosing a phone. The battery life of a phone is measured in a unit known as mAh, which measures electric power over time. mAh is commonly used to describe the total amount of energy a battery can store at one time. A battery rated for more mAh will power a phone for a longer period of time, given the usage pattern. Buyers also compare the quality of cameras when selecting a phone. Now that smartphones have the ability to take high quality pictures with more convenience,

it is important to know how many megapixels the camera has; more megapixels create better image resolution.

Results

Information about weight, standby time, battery life, and camera resolution of the smartphones was gathered from network suppliers' websites which list phones' technical specifications, such as zerizon.com and phonearena.com. (See Table 1.)

Table 1. Output and Input Values

Decision Making Unit	Battery (mAh)	Weight (oz.)	Camera (MP)	Standby Time (hours)	Retail Price (US $)
iPhone 5	1800	3.95	8	225	359.99
HTC Windows 8s	1800	4.6	8	300	399.99
HTC Desire	1230	5.15	5	384	299.99
Samsung Galaxy S4	2600	4.59	13	370	499.99
Samsung Galaxy S4 Mini	1900	3.77	8	300	399.99
Samsung Gusto 3	1000	3.5	1.3	770.4	149.99
LG Cosmos	950	4.58	1.3	818	149.99
Nokia Lumia 928	2000	5.75	8.7	606	399.99

The efficiency scores were calculated by using the Data Envelopment Analysis method and Linear Programming through Excel Solver Software. Table 2 shows the scores, which indicate that four of the eight phones are considered efficient: Samsung Galaxy S4, Samsung Gusto 3, LG Cosmos 3, and Nokia Lumia 928. Phones were considered efficient or inefficient based on the results gathered from using the Excel

Table 2. Efficiency Scores

Type of Phone	Efficiency Score
iPhone 5	0.93
HTC Windows 8s	0.88
HTC Desire	0.91
Samsung Galaxy S4	1
Samsung Galaxy S4 Mini	0.87
Samsung Gusto 3	1
LG Cosmos 3	1
Nokia Lumia 928	1

Solver Software. Those that obtained an optimal solution of 1 were considered to be efficient, and anything lower than 1 was classified as inefficient.

The following table (Table 3) represents the improvements that would need to be made to the four inefficient DMUs in order to become efficient. By altering the inputs and outputs these select devices will become efficient. The values to focus on based off of the efficiency test performed are the battery life and the standby time. From a manufacturer's point of view, battery life is an important improvement because it is at the top of the priority list for consumers. However, this would not be an easy fix and would require extensive research. A study is

Table 3. Recommended Improvements

Decision Making Unit	Battery (mAh)	Weight (oz.)	Camera (MP)	Standby Time (Hours)	Retail Price (US $)
iPhone 5	1800	3.95	8	448.85	336.30
HTC Windows 8s	1897	4.6	8	564.16	350.76
HTC Desire	1566	5.15	5	370	274.43
Samsung Galaxy S4	2600	4.59	13	525.02	499.99
Samsung Galaxy S4 Mini	1900	4.06	8	770.4	348.22
Samsung Gusto 3	1000	3.5	1.3	818	149.99
LG Cosmos	950	4.58	1.3	606	149.99
Nokia Lumia 928	2000	5.75	8.7		399.99

circulating the smartphone-world about using silicon in place of the graphite in batteries in order to prolong the life of these devices (Newman, 2013). This switch of material also comes with limitations because silicon makes the battery swell, which would have implications for the size of smartphones. Eventually there will be a solution to the battery-life complication that will drive the smartphone market in a positive direction.

Conclusion and Limitations

Product comparison is never an easy task, especially when it involves deciding on which phone to purchase. In this paper, the DEA approach is demonstrated as a simple and easy technique for comparing phones. The DEA model is a good way to narrow down a search made difficult by the presence of multiple outputs and inputs.

As a final result, these efficiency scores will be helpful during the purchase decision process. The DEA approach will not only help the consumer, but it can also be beneficial to the manufacturer. Manufacturers can take information from a cellphone comparison via DEA to benchmark specific products and improve how well the product performs.

Including more features whenever those features can be quantified can further extend the DEA model. For instance, this study was limited to features that make up the phone (battery, camera resolution and size), but future studies could focus on the operating systems and applications. The applications available in the App Store contribute to making smartphones more appealing and functional. Therefore, future research could include the number of applications each phone can use as an output variable to determine the influence they have on purchasing efficiency and eventually the consumers' phone-selection results.

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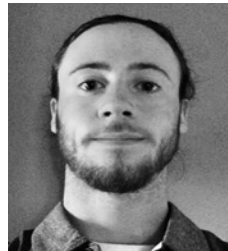
About the Authors

Elissa Turpin is a senior studying Business Management with a concentration in operations, as well as Accounting and Finance with a concentration in finance. She and her research partner, Adam Sanchez, began this project in the fall of 2014 for Dr. Xiangrong Liu's (Management) Production Operations Management course and was later presented at the 2014 BSU Mid-Year Symposium.

Purchasing Efficiency Measurement of Selected Chinese PV Panels Using Data Envelopment Analysis (DEA)

BINGQING ZHENG & PATRICK PRINCE

Introduction

Renewable energy has become a hot topic over the last couple of years. A growing population and the rapid rise of the energy prices around the world drives an increasing need for energy. Solar energy, a type of renewable energy, is cleaner than traditional electricity energy sources such as coal, and has great potential for development. The application of solar energy is accelerating because of its pronounced environmental and economic benefits. It's considered one of the best alternatives to replace fossil energy in the 21st century. Solar energy technologies use the sun's energy and light to provide heat, light, hot water, electricity, and even cooling. The best way to utilize the sun's energy is solar photovoltaic conversion, which is called the photovoltaic effect. The photovoltaic effect uses silicon material to collect sunshine in order to produce direct current electricity. The key element of the technology is the solar cell. As a major electrical device, it converts the energy of light directly to electricity. After a series of solar cells are encapsulated together to protect a large area of solar components, they are coupled with the power controller and other components to form a photovoltaic device such as a solar panel. A general photovoltaic industry production chain has been formed by the development of silicon material, which includes high-purity polysilicon production of raw materials, production of solar cells, solar modules production, and the manufacture of related production equipment.

Although the production process of the solar panels could potentially cause pollution in the environment by using silicon and other toxic metals like cadmium, and the initial cost of purchase and installation is high (Mulvaney 2014), many developed countries have seen the development and utilization of the solar energy revolution as the main content for long-term planning. PV (photovoltaic) is becoming a new industry with internationally explosive growth potential comparable to the IT and microelectronics industry.

China has the largest scale of landscape in the world, with 75% of its land blanketed with evenly distributed sunshine (Luo et al., 2005). As a result of lower labor costs and larger government incentives, China's PV industry is growing faster than any other country. China has become a world leader in solar photovoltaic panel manufacturing; six of its biggest solar companies have a combined value of over $15 billion. With their leading price advantage, China plays a vital role in manufacturing solar PV systems. The top four crystalline module producers are from China, and have been growing their businesses at a rate other competitors are finding difficult to keep up with. Global PV module production reached 40 GW in 2013, an increase of 9% compared to the year before. China has a cumulative solar install target of 15 GW by 2015. China's photovoltaic module production is approximately 26 GW, which increased by 13%. The numbers place China as the world's leading module producer for seven consecutive years. China's PV power generation will play a significant role in the world's future energy supply (People's Daily 2008).

World solar technology has developed rapidly since the 2008 financial crisis. Germany, Japan, and the United States have raised development goals. The growth of energy demand is exploding in today's world, and by 2030, solar power is expected to provide 10% of the world's energy supply. In 2012 many cell and module manufactures, especially Chinese manufacturers, struggled to make a profit or even survive. An aggressive capacity build-up in 2010 and 2011 resulted in excess production capacity alongside extreme competition. The same year, Solar World and six other manufactures started an anti-dumping investigation into China's import of solar panels and their key components, wafers and cells. In international trade, dumping occurs when companies charge a lower price in an export market than in the home country of the producer. In May 2012, the United States Commerce Department announced the preliminary results of the Chinese PV cells and modules anti-dumping duty. The tax rate reached 26%-165% and the Anti-Dumping movement caused Chinese solar PV companies to pay more than 35% of the total tax in order to export their products to the United States. As a result, Chinese solar PV products became less competitive in the United States (PVmagazine 2014).

China was, therefore, forced to switch its focus towards developing the domestic market, especially roof-top systems. A roof-top system is an installation of PV on the roof of residential or commercial buildings. With this kind of system, homeowner consumers can not only generate electricity for their own use, but also sell excess electricity back to the grid. Although this business model, called distributed generation,

has wide applications in European countries and the US, the percentage for application is comparatively small in China. The major domestic installed PV capacity exists as a large-scale solar farm in the northern and western part of China, in poor and isolated areas. Transmission from those areas to the eastern area, which has high economic development and a large demand for electricity, means significant power losses. Therefore, the Chinese government strongly encourages the distribution of PV applications like the roof-top systems. The goal in 2014 is 4 GW in installed capacity as a distributed PV application, which counts for half of new installed capacities. However, as an expert in Chinese PV systems indicated, it is difficult to achieve this goal (Wang 2014). One of the major reasons is the lack of knowledge of solar PV systems and good quantitative models to assist the consumer's decision-making during PV module comparison.

This paper employed a Data Envelopment Analysis (DEA) model to help homeowner customers make decisions in selecting the most efficient PV panels. To analyze the overall purchasing efficiency of solar panels, DEA is a useful technique to analyze the complex nature of the relations when multiple inputs and outputs are involved in the process. The overall purchasing efficiency mentioned in our paper not only includes the technical attributes but also the economical attributes. It measures the ratio of the output performance that solar panels can provide to the purchasing cost incurred by consumers. This measurement implies the combination of features that consumers can receive from the unit price they pay. This research will also aid manufacturers in the goal to improve their panels' efficiency so that they can meet their consumers' need.

The contents of this paper are organized as follows. Section 3 analyzes the basic features and measurements of solar panels. Section 4 introduces the fundamentals of the DEA model, which is the methodology applied. With the data collected, section 5 analyzes the data and provides the solutions. Section 6 concludes the paper with managerial insights and limitations of this study

Literature Review
Most literature analyzed in a technological manner the efficiency of solar panel modules. Pacca et al. (2006) analyzed modeling parameters such as the level of solar radiation, the position of the modules, and the modules' manufacturing energy intensity, which affects the performance of the photovoltaic modules. Mehmet and Dincer (2010) gave a detailed overview of the factors affecting the operation and efficiency of PV systems. The main factors they highlighted were PV cell technology, ambient conditions and selected equipment.

According to Kaldellis, Kapsali, and Kavadias' (2013) one-year outdoor measurement experience, PV solar panel efficiency is influenced by module temperature, climate conditions, wind speed and other technical characteristics. As to our knowledge, none of existing previous research includes economic factors such as price, or takes physical factors such as weight in the consideration. Differing from the previous study, this paper focuses on the overall purchasing efficiency of solar panels combined with technologic efficiency, as well all other factors influencing purchasing decisions.

In order to deal with a multi-dimension comparison, this paper used the DEA model. Charnes, Cooper and Rhode (1978) first proposed the DEA model. DEA measures the efficiency of the decision making units (DMU) with multiple performance factors, which are defined as outputs and inputs. DMU is a set of peer units in the DEA model, and they are the unit under evaluation. The inputs and outputs are the multiple performance measures used for benchmarking. The selection of inputs and outputs are dependent on the data availability and the number of DMUs. For example, in order to evaluate a computer's purchasing efficiency, we could consider different features like screen size, memory size, and processing speed, then classify those features into input or output in order to apply a proper DEA analysis. Once the efficient DMUs are determined, inefficient DMUs can improve their performance to reach efficient by either increasing their current output levels or decreasing their current input levels. The DEA model has recently gained much popularity in the renewable-energy field. It has been widely used in the study of efficiency evaluation and comparison in energy sectors. For example, Shi, Bi and Wang (2010) used the DEA model to determine the Chinese industrial energy efficiency in 28 administrative regions in China.

Dealing with undesirable output is another challenge in this study. Seiford and Zhu (2001) used the classification invariance property to show that the standard DEA model can be used to improve performance by increasing the desirable outputs and decreasing the undesirable outputs. Scheel (2000) used various approaches for treating the undesirable outputs in order to incorporate them into a production model where they must be minimized. The transformation, called additive inverse, sets the undesirable outputs as inputs by changing the sign of the undesirable outputs.

But none of the above research indicates the application of the DEA model in the selection process of the solar panels. This research employs a DEA model to compare different solar panels by considering all of the different criteria, including technological factors, economic factors and physical factors.

PV System Measurements and Input/Output Analysis

The solar modules (or panels) are the key component of a solar photovoltaic system with a complex manufacturing process of polysilicon purification, ingot molding, wafer slicing, cell manufacturing and panel assembly. PV panel performance is generally rated under the Standard Test Conditions (STC) rating, or the Normal Operating Cell Temperature (NOCT) rating. According to the STC rating standards, the panels are subject to an irradiance of 1,000 W/m², spectrum of AM 1.5 and cell temperature at 25 °C. According to the NOCT rating, the panels are subject to an irradiance of 800 W/m², cell temperature at 25 °C, a constant wind velocity of 1 meter per second (2.27mph), and a 45° angle from the sun. The STC rating accounts for optimal conditions and the NOCT rating accounts for factors such as atmosphere and wind, both of which play a large factor in calculating the output of a solar cell. Although the STC rating is displayed on the advertising documents for the panel, the utilities and installers use the NOCT rating when it comes to sizing a PV system, because NOCT is more accurate and complies with realistic conditions. We also follow the major measurements under the NOCT rating. The basic measurements of the solar panel performance parameters include nominal maximum power (Pmax), open circuit voltage (Voc) and short circuit current (Isc), technological efficiency, temperature efficiency, weight and price.

Pmax is the maximum output power, which is the product of the optimum operating voltage and optimum operating current. It's the maximum power point (MPP) of the panel. When the PV system is at its MPP, it operates with maximum efficiency and produces its maximum output power. It is important to be aware of these parameters in order to make the selection process efficiently.

Voc is the maximum possible voltage across a photovoltaic cell in sunlight when no current is flowing;

Isc is the current flow through an external circuit with no load or resistance, which is the maximum current possible.

The module (technological) efficiency, also called a conversion rate, often refers to the amount of electricity generated by one unit of solar light. It is the ratio of the energy output of a solar cell to the input energy in the form of sunlight. High efficiency solar panels maximize the overall return on investment and offer more long-term savings. These solar panels will generate more electricity with fewer panels and require less rooftop space, which leads to less installation time and fewer mounting materials. Most solar panels efficiency is approximately 13-17%. Scientists have developed solar panels that are 40%

efficient in the lab, but there's a vast difference between the lab and the real world (Pure Energies 2014). Manufacturers haven't yet discovered how to utilize the results of these experiments in order to produce more economically viable products.

Temperature coefficient is the change of technological efficiency according to temperature change. Solar panel temperature, which has great influence on the performance of a PV system, is an important factor that affects how much electricity the solar panel generates. The solar panel temperature directly affects the maximum power output. As solar panel temperature increases above 25°C, the panel begins to lose efficiency. The power output of a PV module decreases by approximately 0.35% per additional degree (over 25°C) of cell temperature rise (i.e. -0.35%/°C). Since power is equal to voltage times current, the higher temperature of the solar panel, the less power it can produce. The power loss caused by temperature is also dependent on the type of solar panel being used. An effective improvement efficiency is to reduce the operating temperature of its surface.

Weight is one of the major dimensions that influences customers' selection. Although China does not have strict codes specifying the weight constraints as there is in the US (Hermes 2013), consumers are sensitive to the potential safety issue caused by the weight of the panels. Therefore, the lighter PV panel is preferable to most Chinese users. The solar panel is normally 13kg per square meter (Intelligentenergysolutions 2014).

All of the above six factors to measure the PV panel performance serve as the outputs, which is what customers receives from purchasing. The price is the input variable.

Price is what customer has to pay to buy a PV panel. It is the only input variable for the consumer in this study. Consumers in the PV industry are very sensitive to price. The large investment in PV panels is one of the biggest concerns for customers, despite a 12 to 19% drop in cost nationwide in 2013 reported by the U.S. Energy Department's National Renewable Energy Laboratory (NREL) and the Lawrence Berkeley National Laboratory (LBNL) (PV magazine 2014, Sun and Spicer 2014).

Different panels produced by different manufacturers vary among all these dimensions. The goal is not to find the cheapest PV panel or the lightest one. This study aims to help homeowner consumers find the most worthy one(s) to purchase by comparing all of the above dimensions among the same product category. With our method and solution, the consumer can spend less money and still purchase the panel(s) with the best performance.

Methodology
With all of the above factors taken into consideration, Data Envelopment Analysis (DEA) is an appropriate method to estimated relative efficiency because it is a method that considers multiple inputs and outputs. The DEA model is a non-parametric mathematical programming approach used to evaluate a set of comparable decision-making units (DMUs) (Cook and Seiford 2009). In the DEA model, each DMU has several input variables and output variables, but as an efficiency estimation tool, the DEA model implicitly assumes non-negativity of all inputs and outputs.

The input variables, which are the key parameters of solar panel, transforms to the outputs. The comparison process is complicated because all of the inputs and outputs have multiple dimensions. This structure is same for all of the different decision making units. Therefore, we can calculate the new efficiency by using the weighted output divided by the weighted input. The DEA model attempts to compare the efficiency of different decision making units by using an optimization model. It is trying to find the optimal weights to maximize the efficiency for the target DMU while subject to all other DMUs' efficiencies that are not as optimal as the target. Some DMU units achieve 100 percent efficiency and are referred to as relatively efficient units. Other DMU units that are less than 100 percent are referred to as inefficient units. Therefore our DEA model used is:

Objective function: $\max E^0 = u_1 O^0_1 + u_2 O^0_2 + ... + u M^{O0} M$
$$u,v$$
Constraints: $v_1 I^0_1 + v_2 I^0_2 + ... v_N I^0_M = 1$
$$u_1 O^\eta_1 + u_2 O^\eta_2 + ... + u M^{o\eta}_M - (v_1 I^\eta_1 + v_2 I^\eta_2 ... + v_N I^\eta_N), = 0$$

The objective function is trying to maximize the efficiency (E°) for the target one o. The objective function above is a linear function indicated by the weighted output (Oo) for the target one o, if we can scale the weighted inputs (Io) for the unit under evaluation to a sum of 1.0 in the first constraint. The decision variables above are all the weights for either input variables (denoted as u) or output variables (denoted as v). The weight assigned to output i, with i= 1, 2… M computed in the solution to the DEA model, and weight assigned to input j, with j= 1, 2… N computed in the solution to the DEA model. Where k is the unit during one time period. However, for all other DMUs, their weighted ouput minus weighted input cannot be larger than 0, which indicates that they are not as efficient as the target one. The problem for the targeted one is to get the best combinations of weights in order to make the targeted DMU the best one. If by all means this objective function still cannot reach one, then this targeted DMU fails to be an efficient one. Therefore, we need to solve this problem

for each DMU to see whether they are efficient compared to the other DMUs. Note that the weight of the solar panel is a negative output, which means the lighter the better. The DEA model usually prefers a larger output value because it would increase the final efficiency; therefore, some specific treatment of this negative output is required. There are multiple ways of dealing with negative outputs. The method applied here is called the additive inverse model, designed by Koopmans et al. (1951). Using this method, the undesirable outputs U would be included as an input variable and incorporated into the traditional DEA model as the other input variables.

In sum, DEA is an optimization method to indicate the efficient DMUs. This paper applies this method to evaluate the efficiency of thirty five solar panels, which are chosen from six of the leading solar manufacturers in China. The key features and parameters of solar panels have been defined and they are considered as inputs and outputs of the DEA model. The objective of this paper is to identify, characterize and discuss the key parameters that affect the overall purchasing efficiency of the solar panels.

Data and Analysis
This research collected all the input and output data from the solar panels' specification sheets published on the websites of China's six largest PV manufacturers (Canadiansolar 2014; Jinkosolar 2014; ReneSola 2014; Yinglisolar 2014; Topointsolar 2014; Trinasolar 2014). The unit price of the solar panel is considered as the input and has an average price of 292 dollars. The unit price ranges from 200 dollars to 457.5 dollars. From Table 1 in the Appendix, solar panel JKM310M has the highest Nominal Maximum Power of 230 W, with the range between 167 W to 230 W. The average value of the Nominal Maximum Power is 201.7 W. For the open circuit voltage the average voltage is 38.6 V, and the short circuit voltage has an average of 7.06 Amps, which indicates that all of the solar panels are quite similar in this regard. The average module technological efficiency is 15.28%, which is the industry standard. The price varies by $72.54, but no significant variation was noticed among the other outputs.

After applying the DEA model, we determined the efficiency ratios; they are the final objective function values from the optimization model for each solar panel. Eighteen of the 35 panels are not efficient because their efficiency ratios were less than one. The other 17 panels' efficiency ratios were equal to one. The inefficient panels could be improved by referring to the efficient panels' shadow prices. Shadow price is generally treated as the improvement in the objective function value that results from one additional unit increase in the right side of the constraint. They are the results from the problems,

correspondingly listed in Table 2 in the Appendix. The information is vital in order to improve the inefficient ones by benchmarking the efficient ones.

The example in Table 3 demonstrates the improvement of the inefficient solar panel CS6P 255M. According to the shadow price from the sensitivity report, the combined weighted average of two panels, CS6X300P by 30% and JCS285M by 68%, would provide the specifications to make the CS6P 255M panel efficient (see Table 3). The company could then refer to this information in order to improve the current module, or it can produce a new module based on the data indicated above.

Conclusion and Limitations

Solar energy, which uses sunlight to generate electrical power, is one of the most popular applications of a renewable energy source. It's green, clean, and safe, and a permanent energy source which has become the center of worldwide attention. In this paper, a detailed overview of the purchasing efficiency was presented. By applying the DEA model to compare the numerous solar modules, this research will provide homeowner consumers with the basic knowledge of solar modules features as well as selection tips. In narrowing the selection of the variety of solar modules on the market in terms of purchasing efficiency, the results will assist the purchaser in arriving at a final purchasing decision. According to our research results, seventeen out of thirty five solar panels are efficient with respect to our selected input and output variables; homeowner consumers may then make their selection of the best panel among the most efficient ones according to their preferences. For example, homeowner consumers can further finalize their choices if they have a limited budget or a constraint on the weight as indicated by their roof specifications. Additionally, the improved purchasing efficiency discussed in this paper would help the manufacturers to attract more homeowner consumers and gain a larger market share if they can improve some of their panels' output performance or lower the price by benchmarking the other efficient panels.

There are several interesting implications noticed in this analysis. The results indicate that most Chinese PV modules selected score highly in terms of purchasing efficiency. Although each dimension of the panels is not exactly the same, they do not significantly differ from each other. Based on the theoretical model we designed in this paper and the advanced applications of mobile phones that could implement our model, the selection process could be made easier. However, similar results also indicate that innovation is essential in order for any business to stand out in a competitive market. From the data, we can see that price competition and more successful marketing campaigns would have to trend in this industry

before there is a breakthrough of technological improvement (such as the significant improvement of the conversion rate). There are several limitations regarding our current research. First, although the current research has included all of the major quantitative factors influencing the purchasing efficiency, customers may select a subset of these dimensions according to their specific requirements, especially the physical conditions for installation on site. Second, our current research only included the most influential factors released by the manufacturers, but it can be further extended to other factors. Our research also did not include factors such as a life-time warranty, because all the panels under consideration currently have a twenty-five-year warranty at the current stage. However, manufacturers can gain a competitive advantages by changing these dimensions

Third, limited by the features of DEA models, this project did not include some qualitative factors. These factors include the waterproof feature of the panel, which is still a challenging technical problem nowadays, the quality of after-sale services, which could influence the consumer's motivation for purchasing, and the capability of the panel to work with other solar panel supporting systems (Waterproof Magazine 2009, Solar Industry Magazine 2013). Finally, this paper is also limited in scope of comparison to the major solar module manufacturers from China. Future study can extend the comparison to a greater number of solar modules from different companies in countries such as Germany, the world's leader of photovoltaic capacity, or the United States, which has a combined share of global cumulative installed solar photovoltaic (PV) capacity, or about 35 percent of PV capacity worldwide (Statista 2013). All the limitations mentioned here will provide future research with some direction.

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About the Authors

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Table 1: The Data

	Input	Output					
Solar Panel	Price ($/Unit)	Nominal maximum Power (Pmax) (W)	Open Circuit Voltage (Voc) (V)	Short Circuit Current (Isc) (A)	Module Efficiency (%)	Temperature Coefficient (Pmax) (%/°C)	Weight (lbs)
ELPS CS6P 265MM	241	191	34.8	7.37	16.47	0.45	40.8
CS6P 255M	275.4	184	34.6	7.18	15.85	0.45	40.8
CS6P260M	263.38	188	34.7	7.28	16.16	0.45	40.8
CS6P 250P	245.50	181	34.2	7.19	15.54	0.43	40.8
CS6P 255P	237.15	185	34.4	7.29	15.85	0.43	40.8
CS6P 260P	249.60	189	34.5	7.39	16.16	0.43	40.8
CS6X 300P	287.10	218	41	7.19	15.63	0.43	48.5
CS6X 305P	324.44	221	41.2	7.27	15.90	0.43	48.5
CS6X 310P	304.73	225	41.3	7.36	16.16	0.43	48.5
JKM 240P	250	177	34.7	7.1	14.66	0.41	40.8
JKM 245P	258.02	181	34.7	7.1	14.97	0.41	40.8
JKM 250P	265.18	184	34.8	7.18	15.27	0.41	40.8
JKM 255P	273.75	189	34.9	7.28	15.58	0.41	40.8
JKM 260P	287.15	193	35.2	7.31	15.89	0.41	40.8
JKM 290M	299.62	214	42.8	6.87	14.95	0.4	58.4
JKM 295M	308	218	43.2	6.93	15.20	0.4	58.4
JKM 300M	316.53	222	43.7	6.98	15.46	0.4	58.4
JKM 305M	329.73	226	44.2	7.01	15.72	0.4	58.4
JKM 310M	343.73	230	44.6	7.05	15.98	0.4	58.4
JC285M	428	211	41.6	6.84	14.70	0.4	63.9
JC290M	435	215	41.7	6.91	14.90	0.4	63.9
JC295M	443	219	41.8	6.96	15.20	0.4	63.9*
JC300M	450	222	41.9	7.02	15.50	0.4	63.9
JTM 275P	206.25	202	32.3	6.24	14.20	0.466	49.6
JTM 280P	210	205	41.	6.8	14.40	0.466	49.6
JTM 285P	213.75	209	41.	6.93	14.70	0.466	49.6
YL 305P	457.50	220.9	42.7	7.19	15.60	0.45	59.1
YL 300P	291.30	217.3	42.7	7.1	15.40	0.45	59.1
YL 295P	320.37	214.2	41.4	6.99	15.10	0.45	59.1
YL 290P	269.41	210.6	41.3	6.98	14.90	0.45	59.1
YL 285P	256.50	207.7	41.1	6.89	14.60	0.45	59.1
TSM 230PC	200	167	33.9	6.95	14.10	0.43	41
TSM 235PC	210	171	34.	6.97	14.40	0.43	41
TSM 240PC	235	174	34.1	7.04	14.70	0.43	41
TSM 245PC	240	178	34.2	7.1	15.	0.43	41
Average	292.17	201.7	38.6	7.06	15.28	0.43	53.8
Standard Deviation	72.54	18.69	4.02	0.22	0.01	0.02	9.08

Table 2: Recommended Specifications for Efficiency

Solar Panel	Nominal Max Power (Pmax) (W)	Open Circuit Voltage (Voc) (V)	Short Circuit Current (Isc) (A)	Module Efficiency (%)	Price ($/Unit)	Temperature CoEfficient (Pmax) -%/°C)	Weigth (lbs)
CS6P 255M	210	40.9	6.85	14.78	256.50	0.40	58.4
CS6P 260M	190	34.7	7.30	16.16	255.12	0.43	40.5
CS6P 250P	183	34.2	7.19	15.56	242.38	0.42	40.3
CS6X 305P	224	41.2	7.34	16.12	303.99	0.43	48.4
JKM 245P	182	34.7	7.10	14.97	257.22	0.41	40.7
JKM 250P	185	34.8	7.18	15.27	264.78	0.41	40.7
JC285M	216	41.6	6.84	15.40	323.01	0.39	53.7
JC290M	217	41.7	6.91	15.54	324.27	0.39	53.6
JC295M	219	42.1	6.96	15.66	327.06	0.39	54.2
JC300M	222	42.7	7.02	15.81	331.58	0.40	55.1
YL305P	225	42.7	7.19	16.08	328.18	0.41	53.9
YL300P	217	42.7	7.10	15.42	279.24	0.43	55.3
YL295P	210	39.7	7.02	15.33	310.74	0.41	55.6
YL290P	211	41.3	6.98	15.07	269.13	0.43	52.6
YL285P	208	41.1	6.89	14.74	247.88	0.43	52.3
TSM235PC	171	34.0	6.97	14.40	209.1	0.43	40.8
TSM240PC	178	34.1	7.04	14.95	231.10	0.42	40.3
TSM245PC	179	34.2	7.10	15.11	236.18	0.42	40.3