

# ASTRA

The McNair Scholars' Journal

# 2021





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University of Wisconsin  
Eau Claire

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**Message from Provost and Vice Chancellor  
Patricia A. Kleine**

COVID -19 has certainly continued to disrupt much of the University's "normalcy" during Academic Year 2020-2021. Even workspaces and face-to-face meetings were relegated to desks at home and virtual conversations using computers. However, despite accommodations being made in response to the pandemic, undergraduate student-faculty research flourished.

UW-Eau Claire has long been recognized as the University of Wisconsin System's Center of Excellence for Faculty and Undergraduate Student Research Collaboration. In 2016, UW-Eau Claire received the National Council on Undergraduate Research's (NCUR's) campus award for Undergraduate Research Accomplishments. In 2023, UW-Eau Claire will host NCUR's annual conference which will bring to campus 4,000-5,000 faculty and student researchers. Lastly, in the University's new 2025 Strategic Plan, one of only three goals is to reach an even higher level of national recognition for undergraduate research.

No program exemplifies the institution's commitment to opportunities in undergraduate research for students more than UW-Eau Claire's Ronald E. McNair Post-Baccalaureate Achievement Program. Because of the high academic quality of students' studies, McNair scholars have been named Fulbright, Goldwater, Truman, and Rhodes Scholars. This journal presents the culmination of two years of students working with their faculty mentors on critical questions in their disciplines and preparing their research for professional publication and presentation.

To the students, congratulations on the completion of your research projects, and best wishes for continued success in graduate school.

To my faculty colleagues, thank you for mentoring these remarkable students so well. I continue to celebrate your exceptional commitment to student success and applaud your resiliency during this challenging academic year.

To the reader, I hope you enjoy reviewing this journal and the wealth and breadth of research within it.

**Patricia A. Kleine**  
Provost and Vice Chancellor  
for Academic Affairs  
Academic Year 2020-2021

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# Numerical Simulation of Atmospheric Passage of Interplanetary Dust Particles

Tyler Gonzales  
Dr. Paul Thomas and Dr. Philip Ihinger

## Abstract

Numerical methods have been utilized in applied mathematics and physics for decades. The numerical simulation of trajectories of particles is an interesting topic to many professionals including physicists, mathematicians, and geochemists. Quite frequently, interplanetary dust particles fall to Earth's surface and can be separated from terrestrial dust and analyzed. In this project, we develop a Python-based numerical model, which relies on the finite difference method (FDM). Our numerical simulation results show that atmospheric deceleration for micrometeorites occurs at high altitudes (80 km) and converts sufficient kinetic energy to heat that can potentially melt the micrometeorites entirely, a result consistent with laboratory analysis of recovered samples.

## Keywords

Micrometeorites, Numerical Simulation, Finite Difference Method, Atmospheric Entry

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## 1. Introduction

Micrometeorites (see Figure 1 and 2) are interplanetary dust particles that offer important insights into Earth's origin and the nature of our solar system. They are tiny rock bodies that range from roughly  $50 \mu\text{m}$  to 2 mm in diameter. There are numerous methods that have been used to collect and analyze such stones. [15].

Until recently, much was unknown about such meteorites and how their trajectories interplay with their chemical composition and physical characteristics. In fact, the development of a complete geochemical analysis of micrometeorites remains a goal of scientists to this day. There have been models developed for meteorites that are not on a micro-scale, however, and it should be pointed out that [2, 8, 9] are great sources for those

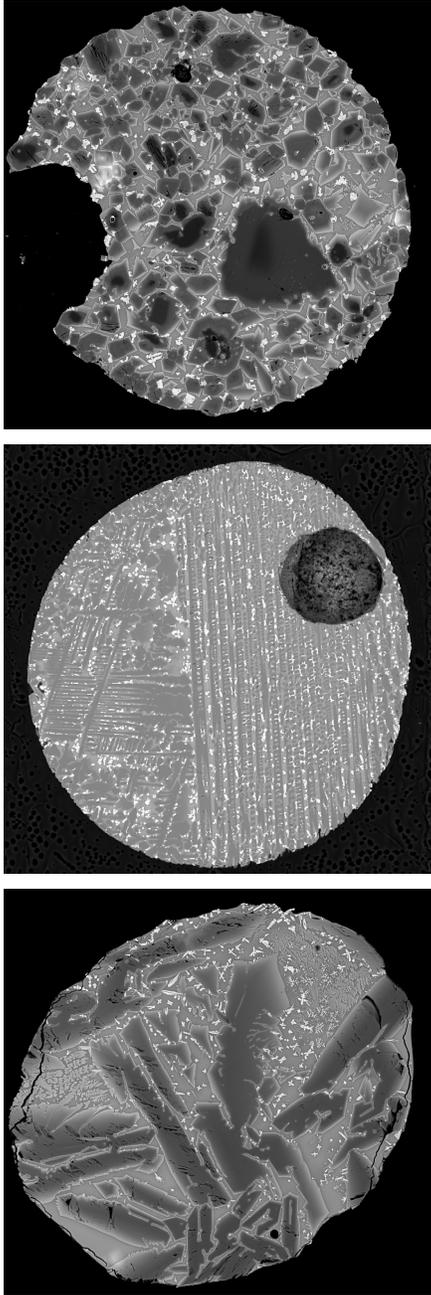
interested in other astrophysical models.



Figure 1. Micrometeorites collected from urban rooftops [15].

In this article, we develop a Python-based trajectory model for the atmospheric passage of micrometeorites of various sizes with the aim of comparing our results with the observable data that is already known about meteorites. The simulation is based on the finite-difference method (FDM), a numerical technique that can be used to solve complicated systems of differential equations. Though other more complicated techniques can be used to solve some Partial Differential Equations (PDE), such as the finite element method (FEM), FDM is a suitable numerical technique which produces satisfactory results

while requiring less computational sophistication.



**Figure 2.** Photomicrographs of micrometeorites. Images taken by Dr. Anette von der Handt at the microprobe facility in the Department of Earth and Environmental Sciences at the University of Minnesota. Micrometeorite samples collected by Scott Peterson of New Hope, MN. Variations in crystal sizes and shapes reflect different thermal histories for the meteorites.

The following sections are organized as follows: in Section 2, a discussion of the needed physics and governing equations of motion is provided, followed by definitions of parameters used in the model. In Section 3, we discuss the density model used in this simulation. Section 4 outlines the theory behind FDM, and how we apply this technique to the equations of motion for our simulations. In Sections 5 and 6, we present simulations of large-sized objects and micrometeorite-sized objects, respectively. In Section 7 we discuss a preliminary heating model. The final section of this paper includes a closing discussion of the findings, as well as some possibilities for future work and acknowledgements.

## 2. Input Physics

Classic trajectory equations, which explain both change in velocity with time and change in angle of atmospheric entry with time, are

$$m \frac{dv}{dt} = -\frac{1}{2} C_D \rho_a A v^2 + mg \sin \theta, \quad (1)$$

$$\frac{d\theta}{dt} = \frac{g \cos \theta}{v} - \frac{C_L \rho_a A v}{2m} - \frac{v \cos \theta}{R_p + z}, \quad (2)$$

where the angle of the trajectory  $\theta$  is measured from the horizontal (for example, a vertical trajectory corresponds to an angle of 90 degrees). In (1) the term  $-\frac{1}{2} C_D \rho_a A v^2$  accounts for (quadratic) drag on the object, which includes constants  $C_D$  (the drag coefficient),  $\rho_a$  (atmospheric density), and  $A$  (cross-sectional area of the object). The second term in (1) represents a gravitational acceleration component.

In (2) the first term is a gravity component, the second is a lift term including  $C_L$  (the lift coefficient), and the third term takes into account the sphericity of the gravitational field associated with Earth. Together, (1) and (2) give the basis of a trajectory model that can be solved using numerical schemes, such as FDM.

When entering the atmosphere, the micrometeorites interact with air particles, causing the rock to heat up upon entry. Once the energy is transferred to the micrometeorites, their temperature will rise. This heating and interaction of particles can lead to ablation, which is generally written as a mass-loss equation [5]

$$Q \frac{dm}{dt} = -A \min \left( \frac{1}{2} C_H \rho_a v^3, \sigma T_{\max}^4 \right). \quad (3)$$

In (3),  $Q$  (the heat of ablation) is a variable depending on material type and ablative process, and  $C_H$  is the heat-transfer coefficient. Values of  $Q$  for various types of micrometeorites are given in Table 1 [8]. The first component of the minimum in (3),

$$Q \frac{dm}{dt} = -A \frac{1}{2} C_H \rho_a v^3,$$

**Table 1.** Parameters for Micrometeorites [8]

Type	Density (kg m <sup>-3</sup> )	Velocity (m s <sup>-1</sup> )	Q (MJ kg <sup>-1</sup> )
Iron	7900	15,000	8.0
Stone	3500	15,000	8.0
Carbonaceous	2200	15,000	5.0
Short Period Comet	1000	25,000	2.5

is a valid ablation model for higher altitudes in the atmosphere (this is where most meteorites would burn up and form the so-called *meteor trails* [5] we can sometimes see in the sky). However, for lower altitudes, say  $z < 30$  km, we need an ablation model that accounts for the increased amount of kinetic energy which is absorbed as a result of ionized gas at the shock front of atmospheric entry. These temperatures are extremely high (around 25,000 K), and so the maximum ablation rate at these temperatures is given by

$$Q \frac{dm}{dt} = -A\sigma T_{\max}^4,$$

where  $\sigma$  is the Stefan-Boltzmann constant  $\sigma = 5.676 \times 10^{-8} \text{ Wm}^{-2}\text{K}^{-4}$  and  $T_{\max} = 25,000 \text{ K}$  [3].

The term  $\sigma T_{\max}^4$  comes from radiative heating of the micrometeorite, which involves ideas from thermal radiation. We introduce a term  $q^{(e)}$ , which is the energy emitted (from a *black body*) per unit area per unit time. The *Planck Distribution Law* gives an expression for the energy emitted by a blackbody as a function of both wavelength and temperature [14]:

$$q_{b\lambda}^{(e)} = \frac{2\pi c^2 h \lambda^{-5}}{\exp\left(\frac{ch}{k_B \lambda T}\right) - 1}.$$

Here,  $c = 3.0 \times 10^8 \text{ ms}^{-1}$  (the speed of light),  $h = 6.624 \times 10^{-27} \text{ erg s}$  (Planck's constant), and  $k_B = 1.380 \times 10^{-16} \text{ erg K}^{-1}$  (Boltzmann's constant).

The total emissive energy of a black body can therefore be determined by integrating the Planck distribution law over wavelengths  $0 \leq \lambda < \infty$ :

$$q_b^{(e)} = \int_0^\infty q_{b\lambda}^{(e)} d\lambda = \int_0^\infty \frac{2\pi c^2 h \lambda^{-5}}{\exp\left(\frac{ch}{k_B \lambda T}\right) - 1} d\lambda.$$

Upon evaluation of this integral, we see find that the total emissive energy of a blackbody is

$$q_b^{(e)} = \frac{2\pi^5 k_B^4 T^4}{15c^2 h^3} = \sigma T^4.$$

Replacing  $T$  with  $T_{\max}$  in this equation gives our maximum ablation rate under high temperatures, as in (3).

When considering heat flow for the micrometeorites, there is the heat due to ablation and radiation, and the internal heating of the micrometeorite with time. The following discussion is about the internal heating of the micrometeorite during its fall through the atmosphere. Heat flow in three-dimensions - for isotropic materials - and heat-flux are related through Fourier's law of conduction [14]

$$\mathbf{q} = -k\nabla T, \quad (4)$$

where  $k$  is the thermal conductivity, or a measure of ability to conduct heat, and  $\nabla T$  is the temperature gradient. Typical units for this  $k$  are in  $\text{Wm}^{-1}\text{K}^{-1}$ .

A solution to (4) would be a temperature distribution in spatial coordinates. Temperatures are frequently time-dependent quantities, and the temperature at a future time and coordinate in space is a solution of the heat equation

$$\frac{\partial T}{\partial t} = \alpha \nabla^2 T = \alpha \Delta T, \quad \alpha = \frac{k}{\rho C_v}$$

where  $\alpha$  is the thermal diffusivity; this quantity measures the rate of heat transfer through a material ( $\rho_m$  and  $C_v$  are the density and specific heat of the material, respectively).

We can compare the rate of heat conduction with the micrometeorite to the ablation rate of the surface of the rock. The rate of heating of a the surface is approximately [19]

$$\kappa_H = \frac{k}{\rho_m C_p},$$

where  $C_p$  is the heat capacity of the object. Assuming the surface temperature is  $T_0$  and the internal of the rock is  $T = 0$ , then the temperature at future all time increments at a radial distance  $r$  inside the micrometeorite is given via the integral equation

$$T(r, t) = \frac{2T_0}{\sqrt{\pi}} \int_{\frac{r}{2}(\kappa_H t)^{-1/2}}^r \exp(-\mu^2) d\mu.$$

We can directly solve the integral equation using a readily available solver. The resulting solution will give us a temperature distribution as a function of time and location within micrometeorite.

The amount of drag and heating experienced on the micrometeorite depends on the atmospheric density at various heights. Though approximate models exist for atmospheric density (in terms of simple exponential functions), more realistic models use interpolation to approximate values of atmospheric density at given heights for the most accurate results.

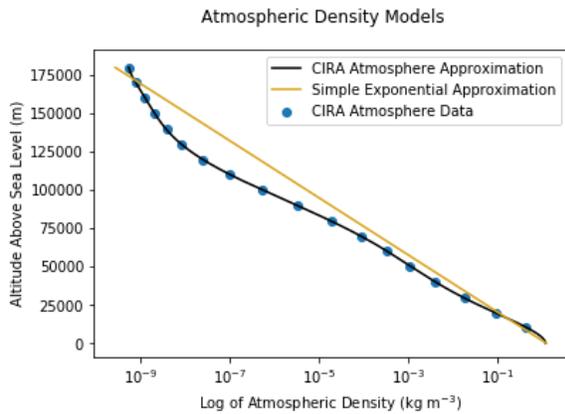
### 3. Atmospheric Density Considerations

A large factor in this simulation, and every astrophysical model which involves an atmosphere, is the best way to account for atmospheric density. This is a rather difficult task, as the density is not uniform with height. Rather, the atmospheric density varies with height, temperature, and location. We use the *COSPAR International Reference Atmosphere* (CIRA) as the foundation of our atmospheric model.

The CIRA models are developed by the Committee on Space Research (COSPAR) and are widely respected models that are used in preparations for space flight. We can use the data provided in the CIRA model to approximate the density of the atmosphere up to 180 km. To do so, we consider a combination of a seventh-order polynomial approximation with a function inside an exponential function of altitude  $z$ . This results in the approximation

$$\rho_a(z) \simeq 10^{f_p(z)},$$

where  $f_p(z) = a_0 + a_1 z^1 + \dots + a_7 z^7$ . The coefficients  $a_i$  ( $1 \leq i \leq 7$ ) depend on the recorded data in CIRA.



**Figure 3.** Log of density plot comparing the CIRA model and a simple exponential approximation.

The coefficients for the approximation are provided in Table 2. This seventh-order approximation technique was originally developed by the Air Force Geophysics Lab in 1985 [13].

Figure 3 compares the best-fit of the CIRA data to the simple exponential model. The CIRA data deviate noticeably from the simple exponential atmospheric model at altitudes of greater than 75 km. We show that applying the more accurate model (or the fit to the CIRA data) results in significant differences in the trajectories and thermal histories of micrometeorites. Though using a simple exponential decay model for atmosphere  $\rho_a(z) \simeq \rho_0 \exp(-z/H)$ , where  $H$  is the scale height, is

appropriate for models which do not involve high altitude considerations, we need the additional complexity and realism obtained by using the CIRA data to obtain the most realistic simulation results.

**Table 2.** Coefficients for the Polynomial Approximation

Coefficient	Value
$a_0$	$7.001985 \times 10^{-2}$
$a_1$	$-4.336216 \times 10^{-3}$
$a_2$	$-5.009831 \times 10^{-3}$
$a_3$	$1.621827 \times 10^{-4}$
$a_4$	$-2.471283 \times 10^{-6}$
$a_5$	$1.904383 \times 10^{-8}$
$a_6$	$-7.189421 \times 10^{-11}$
$a_7$	$1.060067 \times 10^{-13}$

### 4. Numerical Techniques

The primary tool used in developing the model is FDM. This technique is used to approximate the derivative of a function using a sequence of finite differences. In this section, we briefly explain this method. The derivative  $f'(t)$  of a function  $f(t)$  can be approximated via the finite difference

$$f'(t) = \frac{df}{dt} \simeq \frac{f(t + \Delta t) - f(t)}{\Delta t}.$$

Given our trajectory equations, we can apply this finite difference scheme to obtain a discretized set of equations modeling the trajectory of an object of mass  $m$ . Take, for example, (1). We can apply the finite-difference approximation

$$\frac{dv}{dt} \simeq \frac{v(t + \Delta t) - v(t)}{\Delta t}$$

to (1). After multiplying through by mass, the approximation is

$$m \frac{dv}{dt} = -\frac{1}{2} C_D \rho_a A v^2 + mg \sin \theta \simeq m \frac{v(t + \Delta t) - v(t)}{\Delta t}.$$

Dividing both sides by  $m$  gives

$$-\frac{1}{2m} C_D \rho_a A v^2 + g \sin \theta \simeq \frac{v(t + \Delta t) - v(t)}{\Delta t}$$

so that

$$v(t + \Delta t) = v(t) - \frac{C_D \rho_a A v^2 \Delta t}{2m} + g \Delta t \sin \theta. \quad (5)$$

Similarly, we can obtain formulae for discretized angle and mass relationships. After applying FDM to (2) and (3), we obtain the relationships

$$\theta(t + \Delta t) = \theta(t) + \frac{g \Delta t \cos \theta}{v} - \frac{C_L \rho_a A v \Delta t}{2m} - \frac{v \Delta t \cos \theta}{R_p + z} \quad (6)$$

and

$$m(t + \Delta t) = m(t) - \frac{A\Delta t}{Q} \min\left(\frac{1}{2}C_H\rho_a v^3, \sigma T_{\max}^4\right). \quad (7)$$

Height at each step can also be determined using

$$z(t + \Delta t) = z(t) - v\Delta t \sin\theta.$$

In general, given a time-dependent function  $\gamma(t)$ , we think of  $\gamma(t + \Delta t)$  representing the function  $\gamma$  at the new (updated) time value  $t + \Delta t$ , giving the updated value of  $\gamma$  at each point along the process. The quantity  $\Delta t$  is known as the time-step, and is set at the beginning of the simulation. Therefore, in (4), (5), and (6), the quantity on the left side of each equation should be thought of as the new value obtained through finite-difference steps, while the value on the right is the previous value in the iteration.

We will refer to (5), (6), and (7) as the discretized (finite-difference) equations of motion for a particle of mass  $m$ . Since the original differential trajectory equations are complicated, and mass is not constant, we choose to employ these finite-difference techniques to solve the original equations of motion. The benefit of numerical solutions is that the discretized equations of motion are able to be imported directly into Python and solved using computational tools.

### 5. General Simulations

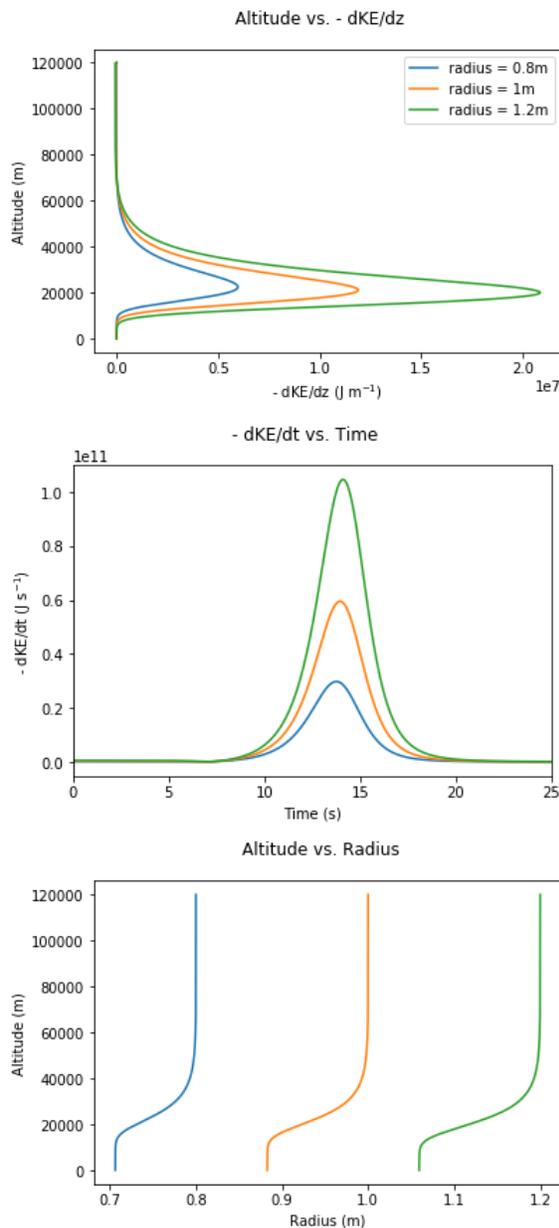
Since the idea of micrometeorites still may seem foreign to some readers, we figure a discussion on some of the physical behavior (and intuition) behind atmospheric entry would be best suited in the case of larger objects. Parameters for these simulations are included in Table 3.

**Table 3.** Parameters for Initial Simulations

Parameter	Value	Units
Scale Height ( $H$ )	8100	m
Heat of Ablation ( $Q$ )	$8 \times 10^6$	$\text{Jkg}^{-1}$
Drag Coefficient ( $C_D$ )	1.7	N/A
Lift Coefficient ( $C_L$ )	$1 \times 10^{-3}$	N/A
Heat Transfer Coefficient ( $C_H$ )	0.1	N/A

As a remark on two of the coefficients in Table 3,  $C_H$  was determined from photographic evidence of meteors [5], and  $C_L$  was observationally determined as well [18]. These numerical values do not actually change much from object to object, so these will remain consistent throughout. The simulations were ran with a step-size of  $\Delta t = .01$  s.

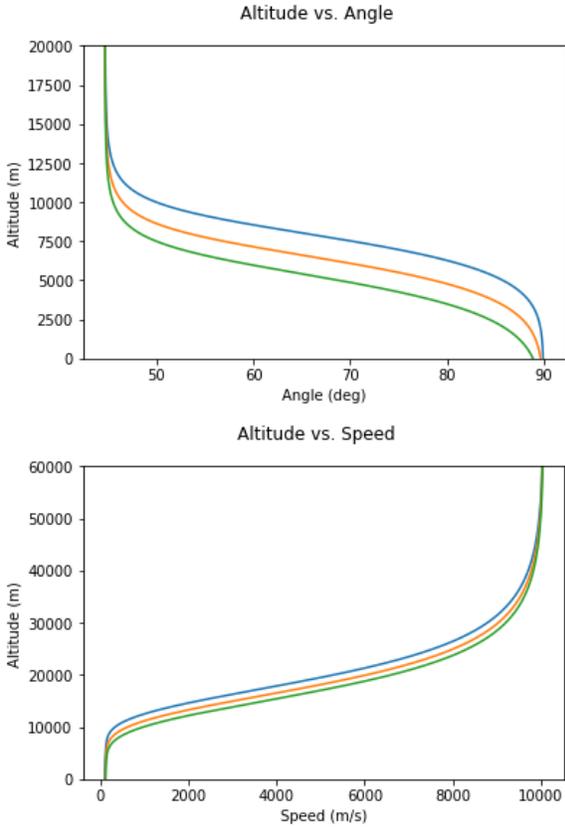
From these first plots we can make a couple of interesting comments. First, note that most of the kinetic



**Figure 4.** Results for a general simulation showing kinetic energy dispersion into the atmosphere, kinetic energy loss with time, and ablation with altitude.

energy is dispersed at altitudes of just above 20 km for meteorites with radii on the order of 1 m. Second, the time span of this loss would be no greater than 10 s. We can also approximate an order of magnitude analysis on heating for meteorites from these plots, but we will do so just for micrometeorites in the next section. We also produce simulations that model ablation, change in

speed, and angle, with height. Recall that this is done by running FDM on (1), (2), and (3).



**Figure 5.** Results for a general simulation showing change in angle and change in speed with time. Legends for these plots correspond to the legend given in Figure 3.

Figure 5 shows that ablation of small meteorites begins at around 40 km, and the angle fluctuates from an initial entry angle of 45 degrees to the horizon to a completely vertical trajectory. The meteorites reach terminal velocity at under 10 km. Another simulation, which is not shown here, show that these larger rocks take from around 80 s to 100 s to reach  $z = 0$  m.

### 6. Micrometeorite Simulation Results

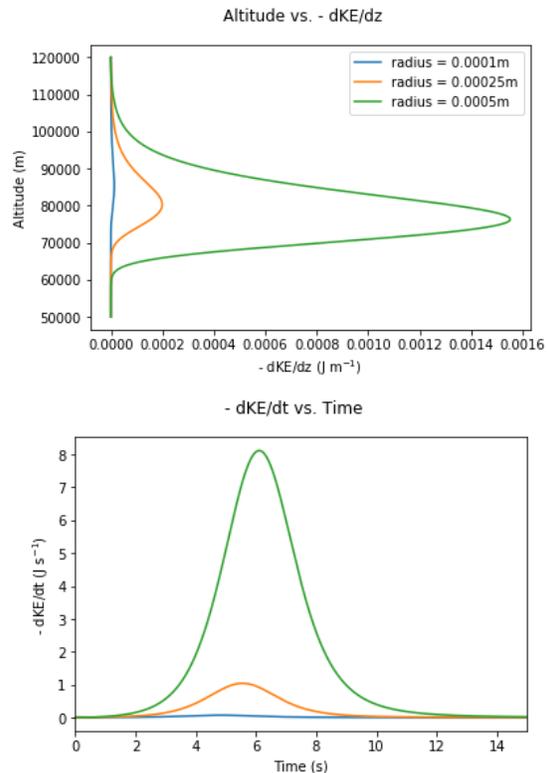
The overall goal of the numerical model is a simulation for micrometeorites, and comparing the results obtained here for larger sized meteorites from the previous section. Since simulations involving very small data values can be computationally expensive for our differential equations, we need to investigate a stopping condition for our simulation that does not cause us to lose any of the important physics. The largest infinitesimal change in kinetic energy with change in height occurs at high

altitudes greater than 60 km micrometeorites, so we can assume most of the important data we need will also occur at these altitudes. For this reason, we end the simulation once the velocity reaches terminal velocity. That is,

$$v = \sqrt{\frac{2mg}{\rho_a A C_D}}$$

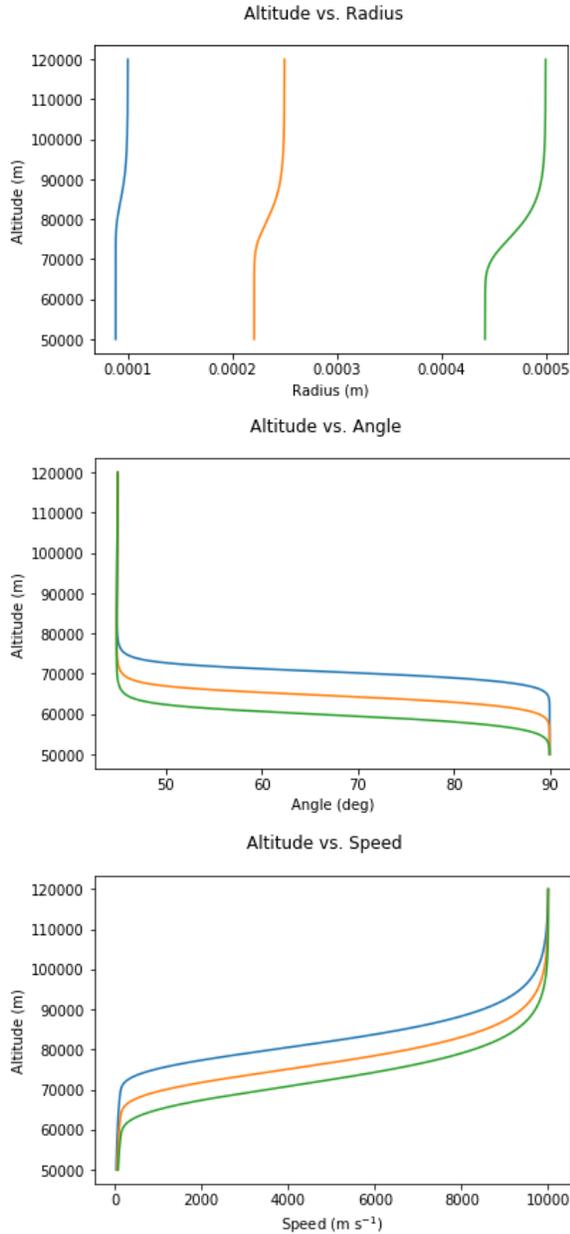
Though this stopping condition makes physical sense, it turns out it is still rather computationally expensive. After running a couple of simulations, it can be shown that we can stop the finite difference calculations at approximately terminal velocity, or heights where this value is obtained.

For these simulations, a time step of  $\Delta t = .01$  was used, and parameters for micrometeorites are the same as those in Table 2. The stopping condition for these simulations will be set to end once a height of 50 km is reached, it can be shown that this is essentially the height at which terminal-velocity is reached for the micrometeorites in this model, as the results will show.



**Figure 6.** Results for a micrometeorite simulation showing kinetic energy dispersion into the atmosphere and kinetic energy loss with time.

Notice how much higher ablation begins to occur here than with larger meteorites, ablation begins to become



**Figure 7.** Results for a simulation of micrometeorites. These plots ablation (change in radius) with altitude, change in trajectory angle with altitude, and change in speed with altitude.

important around 90 km compared to 40 km. This reinforces the importance of the need for an accurate density model for higher altitudes, even though the density is essentially zero beyond a certain point, the impact that the density function has on the modeling equations is certainly nonzero. Note also when terminal velocity is

reached,  $z \simeq 50 - 70$  m.

We also should consider what happens when the angle of the trajectory  $\theta$  is varied. The results of the simulations show that, for vertical trajectories, the micrometeorites are able to penetrate lower into the atmosphere before noticeable deceleration, and experience a shorter duration of deceleration. Vertical trajectories also correspond to more intense heating. For shallower trajectories, the micrometeorites slow down at higher altitudes, have a longer period of deceleration, and experience less intense heating.

### 7. Preliminary Thermal Analysis

We are now able to consider a preliminary heating model for the micrometeorites encountered, for example, in Section 6. This model is simply an order of magnitude estimate for an extreme case, assuming that all of the energy loss goes into heating the micrometeorite from radiative heat transfer from the shock wave. This will require a value of time duration for a heat pulse, which can be found from Figure 6. We first need to relate the total energy  $E_T$  to the temperature. We define the total energy per unit mass to be

$$e_t = C_v t + \frac{1}{2}v^2 + \phi,$$

and integrate over some control volume  $\Omega$  to obtain

$$E_T = mC_v T.$$

As an example, consider a micrometeorite with  $r = .001$  m with  $\rho_m = 3000 \text{ kg m}^{-3}$ . Then,  $m$  is on the order of  $10^{-5}$ . From the plot of  $dKE/dt$ , there is a heating pulse of roughly  $-35 \text{ J s}^{-1}$  for 2 s. Therefore, an estimate for values of  $T$  are

$$T \sim \frac{70 \text{ J s}^{-1}}{10^{-5} \text{ kg} \cdot 1000 \text{ J kg}^{-1} \text{ K}^{-1}} \sim 7 \times 10^3 \text{ K}.$$

This discussion can be refined even further, however. Assume that the initial kinetic energy is equal to the final thermal energy of the micrometeorite, which again is a limiting case as much of this thermal energy would be lost due to radiation, but in this case, we have

$$\frac{1}{2}mv_0^2 = mC_v T_f.$$

Solve for  $T$  to show that

$$T_f = \frac{v_0^2}{2C_v}.$$

This tells us that the final temperature would be independent of the mass of the micrometeorite, which is an interesting result.

Now, how would we consider the time needed for heat to diffuse through the micrometeorite? For a semiinfinite slab, this is found by the time-diffusion approximation

$$t \simeq \frac{\ell^2}{\alpha}$$

where  $\ell$  is the distance from the surface of the slab to the point within the surface. For spherical geometry, this is approximated by

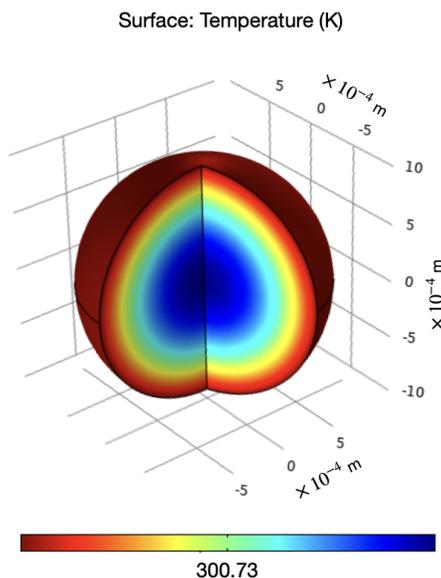
$$t \simeq \frac{r^2}{3\alpha},$$

These time scales are still around 1 to 2 seconds, which is consistent with the results obtained from our simulations.

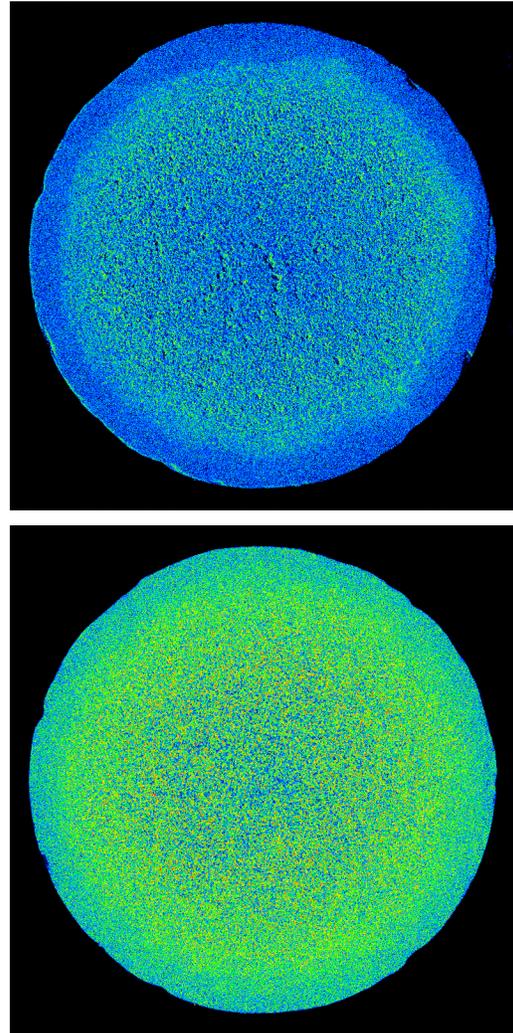
We also need to consider the technique discussed in [19]. That is, consider solutions to the integral equation

$$T(r, t) = \frac{2T_0}{\sqrt{\pi}} \int_{\frac{r}{2}(\kappa_H t)^{-1/2}}^r \exp(-\mu^2) d\mu,$$

which would also give us a temperature distribution inside the micrometeorite which is time-dependent. We obtain a preliminary thermal distribution from a finite element analysis using the COMSOL multiphysics program (reference: www.comsol.com). Results of a COMSOL simulation are given in the following figure.



**Figure 8.** Temperature distribution profile inside a  $r = 1.0$  mm micrometeorite at  $t = .17$  s into a 2 s duration heat pulse with a maximum temperature of 2000 K.



**Figure 9.** Compositional variation inside micrometeorites using backscatter imaging from the electron microprobe facility in the Department of Earth and Environmental Sciences at the University of Minnesota. Micrometeorite samples collected by Scott Peterson; images courtesy of Dr. Anette von der Handt.

## 8. Concluding Remarks

In this paper, we have established a complete micrometeorite trajectory analysis using a Python simulation. We have also discussed a preliminary thermal analysis, which acts as the foundation for future work. We can conclude a couple of interesting observations as a result of this study. First, that some micrometeorites with sizes on the order of  $100 \mu\text{m}$  melt in their passage through the atmosphere, while others don't reach high enough temperatures to do so. Second, we predict that total

heating ( $> 2000$  K) and time duration ( $> 1$  s) is consistent with melting observed in some micrometeorites. We will make this more concrete in future work.

The results of this research also establish that, for vertical trajectories, the micrometeorites penetrate lower into the atmosphere before experiencing noticeable deceleration, and the duration of this deceleration is small. We also can see that vertical trajectories correspond to more intense heating. For shallower trajectories, micrometeorites slow down at higher altitudes, have a longer period of deceleration, and experience less intense heating.

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## Musical String Inharmonicity

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### Introduction

In general, we perceive simultaneous discrete frequencies to be more pleasing if the frequencies have simple ratio relationships with each other. In fact, in the classical western theory of music, the perfect fifth is the most consonant pitch pair, and in the ideal case the frequency ratio between the fundamentals of the pitches would be three to two. By contrast, a dissonant pitch pair, the minor second, has a frequency ratio between the fundamentals of about sixteen to fifteen.

This study examines an effect called inharmonicity as it applies to a single plucked musical string. When a musical string vibrates, it carries many discrete frequencies called harmonics. In the ideal case, these harmonics would vibrate with frequencies that are perfect integer multiples of the fundamental, the lowest frequency being carried by the string. Inharmonicity, in the case that this study addresses, is the behavior where harmonics are pulled higher than their ideal values, and the effect becomes more pronounced as the order of the harmonic increases. A very inharmonic string may even sound out of tune with itself, which might give the string a harsh sound with undesirable resonances.

The model that is tested in this study was brought into the active literature by NH Fletcher in the 1960's.<sup>1</sup> It places the cause of inharmonicity solely on the stiffness of the string material. The equation from which this model is created is:

$$\mu \frac{\partial^2 y}{\partial t^2} = T \frac{\partial^2 y}{\partial x^2} - ESK^2 \frac{\partial^4 y}{\partial x^4}$$

Where  $\mu$  is mass per unit length,  $T$  is the string tension,  $S$  is the cross-sectional area,  $K$  is half of the radius of the string and  $E$  is Young's modulus. Young's modulus for a string is a measure of its resistance to changes in length. In other words, it is a measure of the string's stiffness, so it can be said that it is the parameter that is the first cause for inharmonicity. Equation (1) differs from the wave equation for an ideal string only by the addition of the term that involves the fourth derivative of the displacement of the string from its equilibrium position. So, if the string had no stiffness,  $E$  would equal zero, there would be no extra term in this modified wave equation, and there would be no inharmonicity in the string.

The solutions to equation (1) carry the same assumptions as do the solutions for the ideal wave equation: The string has uniform linear density, it is under constant tension, and the displacement of the string is small enough that tension for any infinitesimal segment does not vary as it vibrates. The solutions also assume that the ends of the vibrating section of the strings are supported, such as a guitar string at the bridge or the nut, or a piano string. This assumption leads to the mathematical statements that at the ends of the string:

$$y = 0$$

That is the string is stationary on the support, and:

$$\frac{\partial^2 y}{\partial x^2} = 0$$

The consequence of this mathematical statement is that the influence of the stiffness of the string material does not travel over the support. In other words, there is no affective curvature of the string over the support. The string can be considered to begin and end at the supports, and for any given instant the slope of the string on the support is constant.

Solving equation (1) will provide a prediction for the frequencies that will be carried by a stiff string in the form:

$$f_n = n f_1^0 (1 + B n^2)^{\frac{1}{2}}$$

Where  $n$  is the order of the harmonic.  $f_1^0$  is the fundamental frequency of the string if it had no stiffness. This is governed by the equation:

$$f_1^0 = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

$B$  is a parameter that contains information about the physical properties of the string.

$$B = \frac{\pi^2 E S K^2}{T L^2}$$

There are some things to notice about the parameter  $B$  in the frequency equation.  $B$  is the parameter that describes the degree of inharmonicity of a given string. As  $B$  is multiplied by the square of the order of the harmonic, its effect is magnified for higher harmonics. Also, the relationship for frequencies carried by an ideal string can be recovered by setting the string's stiffness,  $E$ , to zero, which would make  $B$  zero, which would leave .

The definition of  $B$  also shows that inharmonicity can be lessened by increasing the tension or the length of the string, or it can be magnified by in-

creasing the string's stiffness or diameter. Clearly, a builder of plucked or hammered stringed musical instruments will be forced to balance the different factors that affect inharmonicity. It is not an effect that can be fully eliminated in any practical way.

So, musical string inharmonicity is not merely an academic curiosity. It is an effect that musicians, instrument makers, and other music adjacent professions deal with on a conscious level. This can be seen in the form of instruments. One of the reasons the sound of a grand piano is preferable to a console piano is because the longer strings lessen the inharmonicity. The less affected harmonic frequencies are then more resonant between different pitches, as the frequency relationships will be closer to simpler ratios.

Piano tuners also deal with inharmonicity in a direct way. They will stretch the octaves of the piano, which causes the higher registers to sit a little sharper than would be ideal. Of course, matters of musical perception are complicated, and any statement about what is good or preferable is bound to come with many caveats. Some say that the octave stretching on a piano help make it "livelier."<sup>2</sup>

The struggle with inharmonicity can also be seen in the form and function of guitars. Guitarists will often retune strings to make the overtones resonate in a preferable way in a given key. The G string, which is the thickest unwound string on a standard electric guitar, is notorious for presenting tuning difficulties for the guitarist. Its harmonics can sound harsh, and methods such as detuning the string slightly are employed to lessen the effect. Inharmonicity also helps to explain why bass guitars have much longer necks. Mathematically, the low frequencies on a bass guitar could be achieved by maintaining the short scale length of a standard guitar and increasing the strings' mass per unit length (thicker strings), or by placing them under much less tension. However, doing those two things would increase the inharmonicity of the strings to a degree that would border on unmusical. So, the design of an instrument, in view of inharmonicity, becomes a balancing act between the factors that define it.

### Background

The foundations for this research were laid by Rayleigh in his Theory of Sound in the 1870s<sup>3</sup>

and further developed by Fletcher in the 1960s.<sup>1,4</sup> The final form of the equations that we use come from Fletcher's *The physics of musical instruments*, but he laid out the math in an earlier paper<sup>1</sup>. In that paper, Fletcher measured the inharmonicity of a string for each note on a Hamilton upright piano. His measurements covered both the plain, monofilament strings that are found in the midrange and upper registers of the piano, as well as the wound strings that are found in the lower registers of the piano. In the paper B values were derived from the dimensions of the strings, as it was impractical to remove strings from the piano to make measurements about their properties. This led to difference in B calculations between wound and plain strings. It was found that there is an extra torque provided by windings, and after all of the aforementioned is accounted for, it was concluded that equation (2) gives a good approximation for the frequencies of the harmonics of each string.

Fletcher also notes that a previous paper of his found that "the excellence of the tone from a piano can not be said to be greater or less as the value of B becomes greater or less. There must be an optimum value of B for each string and this value has not yet been found. It is certainly not  $B=0$ , which would mean that all the partials should be harmonic."

In the literature, there is a large body of research examining inharmonicity as it pertains to pianos. Inharmonicity has long been the explanation for the stretched octaves of a tuned piano. To understand why, consider the concept of beats. When two pitches are played on a piano simultaneously, the combined volume will be a fluctuation of the sound intensity. The rate at which the intensity completes a cycle from loud to soft is called a beat. For example, if a 440Hz tone and 442Hz tone are played together, there will result a beat frequency of 2 Hz. While tuning a piano, it is desirable to maintain a particular beat frequency for a certain interval across the range of the instrument. Due to inharmonicity, it is necessary to stretch the octaves to create the desired beat frequencies<sup>5</sup>.

There is also research involving the inharmonicity of guitar strings, with some of it centering on the psychoacoustic aspects of the phenomenon. The form of the guitar lends itself to high levels of inharmonicity. The relatively short scale length and the low tension of the strings, relative to an

instrument like a piano, are the main reason for a level of inharmonicity great enough that the inharmonicity of a single guitar strings can be perceptible to a listener. Järveläinen<sup>6</sup> created listening experiments for steel and nylon stringed guitars. Real recordings were used to create a parametric model of the guitar tones so that the inharmonicity of the tones could be controlled. Through the listening experiments, a threshold was found for the perceptibility of inharmonicity that was close to typical values found on the guitar. It was also found that the inharmonicity was more or less detectable depending on whether or not the attack transients were cropped out. This type of understanding of inharmonicity has uses for digital instrument sound synthesis, where sound creators may want to be able to consider all the factors that make a certain tone sound realistic.

There is also an inharmonicity related explanation for the phenomenon of wound guitar strings "going dead" after some amount of playing time. When a string "goes dead," it has a dull sound with shorter sustain. Houtsma<sup>7</sup> found that this is due to the increased inharmonicity of a well-used wound guitar string. Houtsma simulated the stretching and releasing that is done by playing a guitar string and found that it caused a mass redistribution that causes greater inharmonicity in the partials. This inharmonicity then makes it harder to tune the string exactly and gives it less self-resonance which creates the dull, quickly-decaying characteristic.

Clearly, musical string inharmonicity is a phenomenon that has its consequences in many different areas of the practice of music, from instrument and sound design, to tuning and performance. It is something that has been grappled with on a practical level by musicians and music-related professionals ever since the creation of stringed instruments whose strings are excited by plucking or striking.

This research seeks to extend the understanding of musical string inharmonicity by examining strings of varying constructions and materials using the modern tools available today. Fletcher's equation is used to provide an expectation of behavior for inharmonic partials on a string, and audio recordings are used to provide the data about the actual behavior of the string to be compared to the expected behavior. This work differs from previous work in two ways. First, we

measure the properties of each string directly, such as its dimensions. Each string's Young's modulus and its mass per unit length is also measured instead of derived as in previous work. As stated in the introduction, the Young's modulus, the stiffness of the string material, is the first cause of inharmonicity in a string's behavior, so measuring it directly represents an acknowledgment of this importance.

The second differentiating component to this study is the variety of strings that are measured and examined. We look at monofilament steel guitar strings, that is strings that do not vary in material or geometry across their cross section, and we look at wound steel guitar strings. We also examine the applicability of Fletcher's equation to nylon guitar strings. Nylon does not provide the same type of linear response to stretching that steel does in the range of tensions on a guitar, so it is not clear that inharmonicity will behave the same way for nylon strings. Furthermore, we look at the wound strings of a nylon set of strings. The wound strings on a nylon set are of a totally different construction than wound steel guitar strings. The nylon wound strings have a core made of a thread of nylon filaments, so it is interesting to examine how that affects the inharmonicity.

### Methodology

Each string was examined in two ways, the order of which was determined by practical considerations. First, the string's material properties were measured, so that they could be used with equation (4) to predict a value for their B parameter, which is, in effect, a measure of their inharmonicity. Second, audio of the vibrating string was recorded. With the audio data, a Fast-Fourier Transform provided the discrete frequencies that were present in the audio sample. These frequencies were then used to perform a chi-square fit using equation (2) to provide an experimental value for the B parameter that could be compared against the value that was predicted from material measurements. The two different values for B and the associated uncertainties for each string are then compared.

As previously noted, the order in which these two methods for obtaining a value for the B parameter was performed was determined by practical considerations. For the nylon strings, it was necessary to use strings that were "settled." In

practice, nylon strings will complete many cycles of tensioning and stretching before they reach an equilibrium that allows them to hold a steady pitch for a usable length of time. With this in mind, the nylon strings used in this study were installed on a guitar and retuned daily for 2 weeks to allow them to settle. During this time the strings were not played, other than the plucks required to pitch them back up to the desired operating tension. With the nylon strings installed on the guitar, audio samples were recorded. Then the strings were removed, and the dimensions and Young's modulus were measured.

For the steel strings, the strings' dimensions and Young's modulus were measure first, and then they were installed on a monochord apparatus where audio samples were recorded.

Strings' diameters were measured with a micrometer caliper, and length measurements were done with a meter stick. Uncertainties for these measurements were taken from the tolerances of the measurement devices.

### Measuring Young's Modulus

Young's modulus,  $E$ , is a measure of a material's resistance to changes in length, so to measure the Young's modulus for a string, it is necessary to measure the force provided after measured changes in length.

A given string was clamped at both ends. At one end the clamp was attached to two Pasco force sensors. At the other end, it was attached to a movable stage. The stage was then moved to put the string under a tension that would be slightly higher than its vibrating tension, around 80N for steel strings and around 60N for nylon strings. As the tension was progressively lessened throughout the measurements by moving the stage to reduce the string length, the tension values would pass through the tension that would be used when recording audio of the string as it vibrated. An example of a plot produced by this procedure is shown in figure 1.

For wound strings, the clamps were only attached at segments of exposed cores, and the area used for the Young's modulus calculation was taken to be the area of the core.

It should be noted here that the measurements for nylon strings had to be done rather quickly, to compensate for the "settling" behavior previous-

Young's Modulus  
.011" Steel String

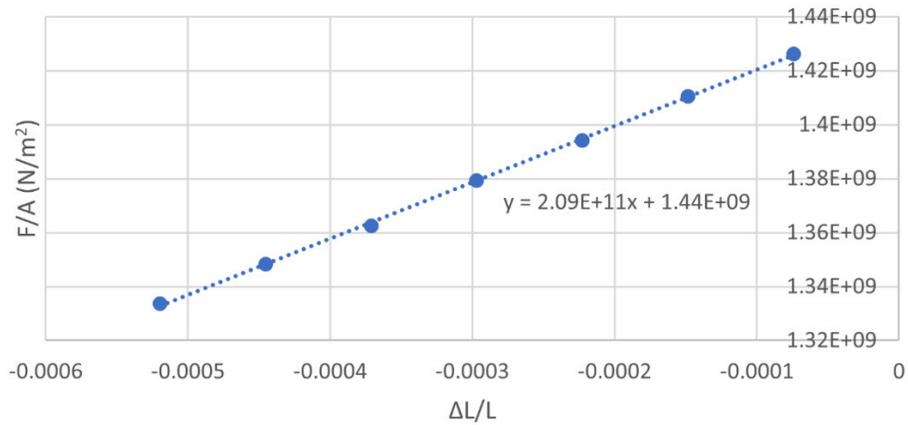


Figure 1 – Scatter plot of the data for the resistance to changes in length for an Ernie Ball .011” steel string. The slope of the trendline of this data gives the Young’s modulus.

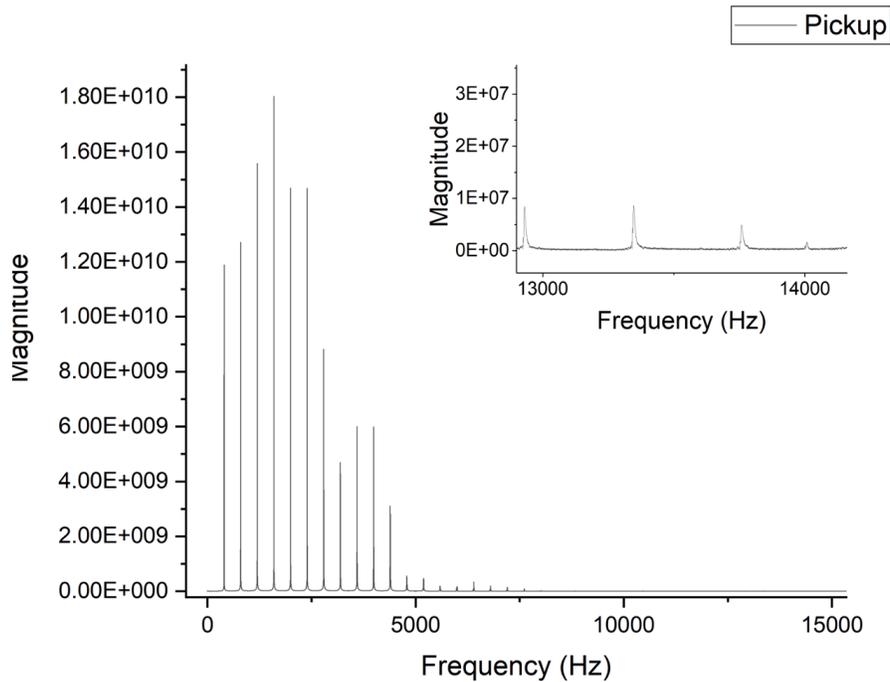


Figure 2 – Plot of output of a FFT from an audio sample of an Ernie Ball .011” steel string. The peaks seen here represent the frequencies present on the string. The inset shows higher harmonic frequencies whose peaks are not visible at the original scaling of the plot.

ly described. When a change is made in the nylon string's length, the tension immediately responds as expected, but it will quickly rebound toward the tension it had before the change in length. Since the minuscule changes in tension while vibrating occur at rates around hundreds of hertz, fast measurements in this procedure would be most relevant to the behavior examined in this study. The values for stiffness obtained are in general agreement with a study done by Lynch-Aird and Woodhouse<sup>8</sup> in which the mechanical properties of nylon strings were examined.

Measurements were plotted and the Young's modulus was given by the slope of a linear chi-square fit. The uncertainty for the Young's modulus was taken from the result of the chi-square.

### Audio Samples

Audio samples were mono recordings taken at a sample rate of 44.1 kHz with a sample length of 4-8 seconds. Although longer sample lengths can, in theory, provide more precise outputs for discrete frequencies, the higher harmonics on a musical string die out rather quickly. Since the amplitude for a frequency in the output of a FFT is, loosely speaking, a measure of its presence in the sample, a long sample length will cause short-lasting frequencies to get lost in any noise in the sample.

Audio samples were always recorded by 2 sources concurrently. Microphones, provided by a Zoom H4n handheld recorder and an LG V20, were used for the nylon strings. For the steel strings, a piezo pickup and an electromagnetic pickup were used.

Strings were each plucked in varying locations. The intensities of the different harmonic frequencies present on a vibrating string are determined largely by the placement of the pluck attack. For example, if a pluck is performed near the end of the string, the higher order harmonics will be emphasized. Varying the location of the pluck attack in the audio samples provided a more complete picture of the string behavior.

Samples from different sources corresponding to the same pluck attack were aligned, and the pluck transients were clipped off the front of the wave forms, then the desired sample length was exported into Origin. The result of this procedure was, for each string, multiple samples from

varying sources and varying placements of the pluck attacks. This data was used to aid in the distinguishing of frequencies originating from the string from any other source of noise.

While determining the frequencies present on the string, a single source was chosen to provide the exact frequencies, while the other sources were used as indicators that a given frequency originated from the string and not elsewhere. A plot representative of one used in the above procedure is shown in figure 2. In many spectra, it was possible to clearly see harmonics of the 50<sup>th</sup> order or greater.

After the string frequencies were determined, they were plotted, and a chi-square fit was performed using equation (2). This provided an experimental value for B, and the uncertainty for this value was taken from the output of the function fit. An example of this function fit is shown in figure 3.

### Results and Discussion

The following charts show the results for the monofilament strings that were tested. These were the types of strings for which the model was derived. It should be noted that guitar strings labelled as nickel are typically nickel-plated steel. Both the steel and the nylon strings performed well, which was not completely expected since the microstructures of the materials are so different. It was not obvious that they should behave so similarly when viewed through the lens of this project.

The uncertainties for the values are too small to display in the graph. Generally, they were about 2 orders of magnitude smaller than the principal values. Half of the monofilament strings tested did not provide overlapping value ranges for the B values, but almost all of those only disagreed by a one to two percentage points or less. There is also no strong pattern of the material measurements providing greater or lesser values of the B parameter when compared to the audio-derived B value, or vice versa.

The largest disagreement between the B values provided by the 2 different testing methods occurred with the 22-mil piano steel. There are very plausible lines of speculation for this disagreement. One being the stiffness of the piano wire interfered with the required end conditions of the string. The testing apparatus was not capable

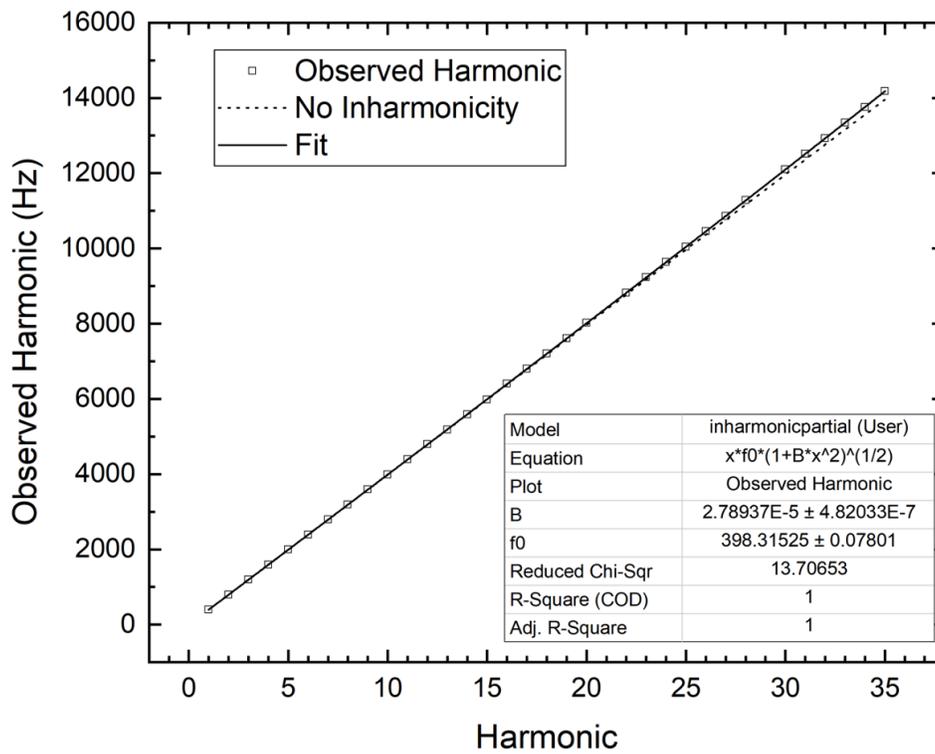


Figure 3 – Plot of the observed harmonic frequencies obtained from Figure 2, along with the fit function's output and the fit line.

String Description	B Measured	$\Delta B$ Measured	B Fit	$\Delta B$ Fit	Uncertainty Overlap
D'Addario NYXL .011" Steel	2.09E-05	4.74E-07	2.05E-05	1.58E-07	Yes
D'Addario NYXL .014" Steel	5.11E-05	1.14E-06	5.01E-05	3.65E-07	Yes
D'Addario NYXL .018" Steel	1.28E-04	2.64E-06	1.36E-04	1.67E-06	No
DRPureBlues .009" Nickel	9.68E-06	2.35E-07	8.86E-06	4.25E-08	No
DRPureBlues .011" Nickel	2.03E-05	3.80E-07	1.95E-05	8.78E-08	No
DRPureBlues .016" Nickel	8.92E-05	1.64E-06	9.25E-05	1.31E-06	No
Ernie Ball 1009 .009" Nickel	1.14E-05	4.84E-07	1.10E-05	8.22E-08	Yes
Ernie Ball 1011 .011" Nickel	2.87E-05	6.47E-07	2.79E-05	4.82E-07	Yes
Ernie Ball 1016 .016" Nickel	9.53E-05	2.05E-06	9.86E-05	9.91E-07	No
Martin Marquis m1200 .013"	3.54E-05	9.51E-07	3.64E-05	1.57E-07	Yes
Piano Wire .022" Steel	3.54E-04	7.40E-06	3.66E-04	2.67E-06	No
ProArteEJ45 .280" Nylon	3.61E-05	1.29E-06	4.23E-05	2.66E-07	No
ProArteEJ45 .322" Nylon	6.23E-05	3.85E-06	6.38E-05	3.08E-07	Yes
ProArteEJ45 .403" Nylon	1.25E-04	3.11E-06	1.25E-04	7.02E-07	Yes

Table 1 - Results for the monofilament strings.

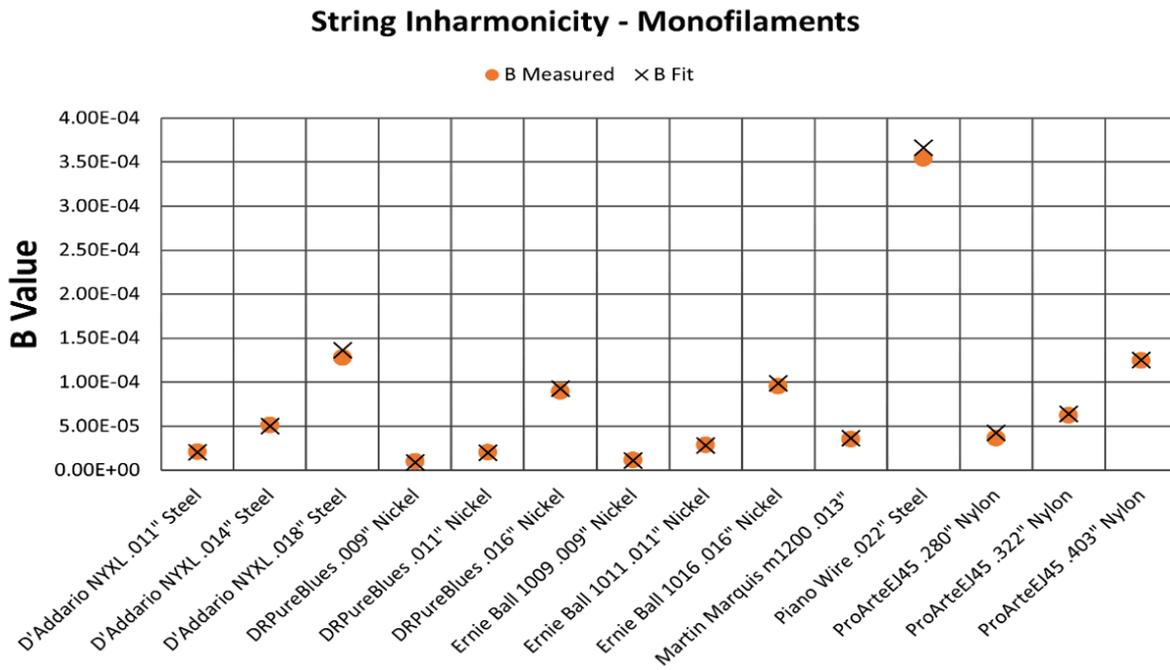


Figure 4 – Scatter plot of the results for the monofilament strings.

String Description	B Measured	$\Delta B$ Measured	B Fit	$\Delta B$ Fit
D'Addario EXL115 .028" Nickel Wound Hex Core	5.54E-05	6.84E-06	5.87E-05	2.70E-07
D'Addario EXL115 .038" Nickel Wound Hex Core	6.02E-05	4.05E-06	6.88E-05	4.74E-07
D'Addario EXL115 .049" Nickel Wound Hex Core	1.07E-04	1.76E-05	1.34E-04	1.85E-06
D'Addario NYXL .028" Steel Wound Hex Core	4.61E-05	1.67E-06	5.34E-05	1.41E-07
D'Addario NYXL .038" Steel Wound Hex Core	6.89E-05	2.02E-06	8.20E-05	1.27E-06
D'Addario NYXL .049" Steel Wound Hex Core	1.04E-04	1.02E-05	1.51E-04	5.25E-06
DRPureBlues .026" Nickel Wound Round Core	4.45E-05	1.21E-06	4.49E-05	1.84E-07
DRPureBlues .036" Nickel Wound Round Core	7.44E-05	1.94E-06	7.93E-05	7.83E-07
DRPureBlues .046" Nickel Wound Round Core	1.04E-04	2.11E-06	1.31E-04	7.22E-06
ProArteEJ45 .029" Wound Nylon	2.53E-05	5.77E-07	1.84E-05	3.36E-07
ProArteEJ45 .035" Wound Nylon	2.94E-05	8.67E-07	1.42E-05	6.71E-07
ProArteEJ45 .043" Wound Nylon	3.23E-05	7.19E-05	1.99E-05	6.40E-07

Table 2 - Results for wound strings.

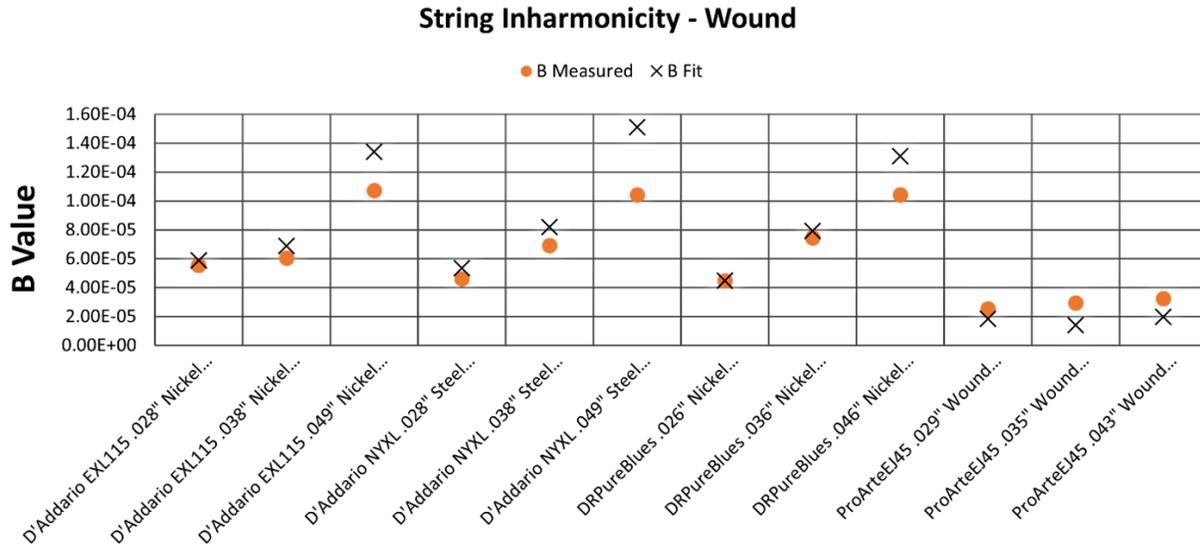


Figure 5 – Scatter plot of the results for wound strings.

of tensioning the string to an amount that would eliminate arcing of the string over the support. It is also possible that for a string of this thickness, the tension was not great enough to keep the string perfectly stationary over the support. This would help explain the behavior of the other thicker steel strings that can be seen in figure 4. During the research, this was an early reminder that string vibration and inharmonicity are phenomena that are quickly complicated by violations of the assumptions that allow the derivation of normal frequencies from the wave equation.

More examples of complicated inharmonicity behavior can be observed in the results for the wound strings.

The geometry and varying composition of wound strings violates the assumptions of the model, but it was interesting to test the behavior. The windings on the strings serve the purpose of increasing the mass per unit length, ideally without affecting the other properties of the string. Increasing the mass per unit length allows a string to support lower frequencies without having to decrease tension or increase the string length. None of the value ranges for the 2 testing methods provided overlaps in the results for the wound strings. In general, the material measurements provided a lower B value than did the frequency measurements. This pattern is reversed

in the wound nylon strings. The core of wound nylon strings is loose thin nylon filaments held together by the metal windings of the string. As such, it was exceedingly difficult to measure a valid cross-sectional area that could be used in the calculation for the respective Young's moduli.

The wound string results show the general trend of thicker strings being more inharmonic than thinner strings. The difference in the B values between the 2 testing methods is greater for thicker strings. With the steel strings, the line fit B being consistently greater than the material derived B suggests some systematic behavior. Modern guitar string manufacturing techniques favor using hex shaped cores for the wound strings. It is possible that the sharp edges of the hex shape dig into the windings and the interaction creates an extra restoring force that increases the inharmonicity. This supposition is supported by the round core wound strings offering less difference between their respective B values than the hex core wound strings.

### Conclusion

This study demonstrated the effectiveness of attributing the inharmonic behavior of musical strings to the stiffness of the string material. For monofilament strings, the value of the B parameter derived from material measurements was overall in good agreement with the value derived

from audio samples. This conclusion holds for both steel and nylon strings. Although some of the uncertainty ranges did not overlap, for monofilament strings the disagreement was within one or two percentage points of the B values. For the wound strings, the disagreement between the B values is not surprising. The model we tested does not account for non-monofilament string constructions. It is likely that there is an interaction between the windings and the core of the string which further complicates the behavior of the string.

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## Effects of Music on Athletic Performance

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### Abstract

Arousal or mental/physical stimulation can have a significant impact on sports performance. By achieving or maintaining an optimal arousal state, athletes can perform better, both mentally and physically. Listening to music during exercise may serve as a tool to achieve and maintain this optimal arousal. The purpose of this study is to explore the practicality of music's use in intense exercise/sport. This study utilized the Broad Jump (BJ) and Illinois Change of Direction Test (ICODT) to assess lower body power and agility. Participants completed three trials of each test to assess their performance. The first trial acclimated the participants to the movements. The second trial used no music, and the last trial used the participant's choice of music. The only song requirement was a tempo of at least ~100BPM (fast tempo). A Paired Samples T-Test showed a mean increase of 0.099m and a standard deviation of 0.0599m from non-music to music trial for the BJ and a t-value of -5.88. The ICODT had a mean decrease of 0.634s from the non-music to music trials, a standard deviation of 0.455sec, and a t-value of 4.402. Both tests produced statistically significant results ( $p$ -value  $<0.05$ ). The results indicate music can facilitate high-level performance.

### Introduction

Listening to music has a profound effect on the brain. It can elicit emotions, help recall memories, improve focus, reduce stress, and improve exercise performance (Atan, 2013; Jarraya et al., 2012). An in-depth understanding of how the brain functions when listening to music, is necessary to comprehend its effects on physiology and cognitive functioning.

Music can alter the neurochemistry of the body, and consequentially, its physiological state. Neurochemistry refers to various neurotransmitters that change the body's internal environment and impact the functioning of different systems (ex. cardiovascular, nervous, respiratory system, etc.). Physical and mental states can vary depending on the neurotransmitters produced, leaving the individual in either a controlled or uncontrolled

state (ex. fight or flight). Music is a positive stimulus that many people use because of its ability to balance these messengers and allows for better control of their arousal levels or levels of stimulation.

When participating in sports, having a clear mind and low stress levels is essential because excessive stimulation can increase perceived exertion, physically and mentally, leading to greater injury risks (Farris et al., 2017). Naturally, the brain wants to stray away from harmful stimuli as well. To do so, physical processes such as muscle firing rate and motor control are slowed down resulting in significant performance declines and increased injury risks.

Additionally, music can create synchronous movement because of tempo manipulating the pace of the body functions. A human's natural adaptation to music can increase an individual's motivation to perform specific tasks. Increased motivation can lead to greater work output and less effort put forth by the individual. This occurs because of the brain seeking pleasure and it is focusing its attention on tasks that may result in a pleasure response. Pleasurable stimuli or anticipation of it creates a release of dopamine from the anterior aspect of the brain. Being motivated to complete a task while being in an ideal mental state is desired because this state of optimal arousal will create better performances (Jarraya et al., 2012).

### **Current Literature**

In the current literature regarding this topic, the information provided by researchers is conflicting (Atan, 2013). Part of the disparity may involve the methodologies used. In particular, the lack of specificity in the testing methods potentially had minimal carryover to athlete's performance during practice, competition, etc. As a result, the use of music as a performance enhancer may have mixed results. More research regarding athletic performance and music should be conducted using more specific methods by mimicking the same or similar motions used in sports. By using more sport-specific testing procedures, the data gathered can provide a better outlook on music's performance-facilitating ability. Functional tests used in Sports Medicine and Strength & Conditioning have high specificity for athletes because they divide different components of athletic movements to test them. Data collected on the relationship between music and performance can be better represented if the testing methods used are more correlated to the activities regularly performed by the athletes.

In comparison to other testing methods, the functional tests for this study will be more specific to athletic skills (Atan, 2013; Pujol & Langenfeld, 1999). Specificity is crucial because the more specific the testing method is, the more carryover it can have for the athlete's ability to perform.

### **What is Arousal?**

Arousal is described as an individual's state of being awake, alert, and attentive (Arousal in Psychology: Definition, 2016). Arousal can affect how motivated someone is to per-

form a single task (Shrestha, 2017; Wu et al., 2017). By achieving the optimal arousal level, the performance of a task can be done to the individual's best ability. However, any deviation from the optimal level might cause a significant decline in performance (Figure 1; Shrestha, 2017).

Arousal can be affected by several factors, such as our senses (sight, smell, hearing, touch, taste), emotional state, and what we consume (food, drugs, etc.) (Arousal in Psychology: Definition, 2016). The effects of different stimuli can vary. The strength and duration of a stimulus are two factors that can influence arousal levels. The neurological responses to stimuli may lead to hormonal changes in the body as well.

Neurotransmitters play a significant role in the level of arousal. They can improve focus on the stimuli present in both the internal and external environment (Arousal in Psychology: Definition, 2016). Neurotransmitters such as dopamine, norepinephrine, epinephrine, and serotonin are the primary messengers that play a role in arousal because of their significance in physiological function.

Dopamine is responsible for producing a pleasure response. It can affect how motivated someone might be due to the pleasure caused by certain stimuli. For example, drugs, sugary foods sugary, and music increase dopamine levels, therefore they create stimuli that can be highly motivating (Haynes, 2018). The pleasure response caused by dopamine also has an inhibitory effect on stress hormones such as cortisol and norepinephrine. As a result, a decrease in perceived exertion is felt by those with exposure to a pleasurable stimulus.

Norepinephrine is responsible for cardiorespiratory changes when stressful stimuli are present (Goldstein, 2010). In high-stress situations, norepinephrine causes vasodilation and increases heart rate (Goldstein, 2010). Epinephrine, also known as adrenaline, can also increase heart rate and blood pressure and cause vasoconstriction of blood vessels. Epinephrine also affects a greater variety of tissues (Goldstein, 2010). In addition to cardiovascular changes, respiratory and skeletal muscle stimulation occurs from modulating epinephrine production. Vasoconstriction makes it easier for blood to flow between tissues and allows muscles to function optimally during exercise.

Serotonin plays a critical role in regulating emotions. It regulates mood, memory, and an individual's ability to learn (McIntosh, 2018). It also sets the tone for the central nervous system and cognitive functioning (McIntosh, 2018). An inadequate level of serotonin is associated with mood-related disorders such as anxiety and depression, both of which affect the ability to think effectively and reduce motivation (McIntosh, 2018). While serotonin is associated with positive stimuli, stressful stimuli do not have a direct correlation with its production. Being in higher stress situations have little effect on the serotonin levels, but increased anxiety can block the neurological response from serotonin when anxiety becomes uncontrolled (Lv & Liu, 2017). Anxiety may be decreased by increasing the pleasure response, thus, improving serotonin level.

These neurotransmitters play a huge role in physical and mental function. While these components of arousal are crucial for positive performances, inappropriate levels can cause a neurological cascade that leads to detrimental changes in skill. For some, it may be difficult to regulate factors that influence the previously mentioned neurotransmitters. Physically active individuals, especially athletes, often seek out tools that ease their ability to achieve optimal arousal levels. These tools may be supplementation, drugs, or music.

### **Music's Effects on Arousal Response**

Current literature supports that music can be used to modulate arousal levels (Pujol & Langenfeld, 1999; Thakare et al., 2017). Pleasure responses created by music can reduce stress and anxiety for individuals because it [music] can modulate dopamine output. In addition to dopamine regulation, norepinephrine, epinephrine, and serotonin can also be controlled by listening to music (Salimpoor et al., 2011; Wu et al., 2017).

Anxiety creates mental fog, which inhibits an athlete's ability to think and focus during activities. While competing in their sport, athletes can also experience high levels of stress, however, it can become uncontrolled and inhibit their performance. Music eliciting pleasurable responses reduces stress and anxiety to manageable levels. By controlling their stress and anxiety levels, athletes can achieve can become optimally aroused or stimulated without the negative effects of too much or too little stimulation (Atan, 2013; Wu et al., 2017). Music also increases motivation to perform, which can potentially boost focus and willingness to push past mental and even physical barriers. Music's use before competitions and during training sessions can likely be attributed to these benefits.

### **Synchronous Movement with Music**

Current literature states there is a correlation between the beat of music and movement (Jarraya et al., 2012; Large, 2000). Changes involuntary movement patterns naturally change while listening to music. The tempo or beat of a song changes the psychological pace, and the body adjusts the rhythm of its internal systems to match it (Jarraya et al., 2012; Large, 2000). An example of a physiological change that occurs as a result of listening to music is heart rate. The external environment plays a role in physiological rates, and if adjusted, the internal environment will follow suit. This phenomenon also occurs within the respiratory and muscular systems (Atan, 2013; Wu et al., 2017).

The beat of the music modulates the pace that the body moves by serving as a "psychological pulse" (Large, 2000). Even when the music producing a pulse change, is no longer present, this byproduct of the auditory stimulus continues temporarily (Large, 2000). Additionally, music establishing the pace of movement can also allow individuals to focus better on the tasks that they perform (Atan, 2013; Large, 2000).

Table 1: Paired-Samples T-Test Results

		Paired Differences 95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Pair 1	BJ w/o music (meters) - BJ w/ music (meters)	- .056536648300 000	-5.246	9	.001
Pair 2	ICODT w/o music - ICODT w/ music(seconds)	.959802992000 000	4.402	9	.002

## Methods

**Participants** Emails were sent to the coaching staff and team captains of both club and varsity athletics at the University of Wisconsin-Eau Claire to obtain player interest and contact information. Then, athletes from both university-sponsored sports and club sports were contacted directly and asked if they would like to participate in the study. Afterward, the researcher email those interested in the study, a schedule for data collection availability.

Those who have experience participating in sports are more coordinated than the average individual. Since the study is looking at using functional methods to assess athletic performance, using athletes was the best option. They would be able to not only perform the tests well but also have a much less chance of becoming injured.

Sports that change in direction often and require a powerful lower body were the source of the participant pool for this study. 10 participants from sports such as Soccer, basketball, rugby and football, and softball were involved in the study.

## Functional Testing Methods

In the strength & conditioning and sports medicine fields, coaches and clinicians use several functional tests to assess an athlete's ability to perform sport-specific movements. These tests are used to measure baseline performance, post-training cycle abilities, and measure post-rehabilitation progress. Most sports require an athlete to move fast and be agile. Change-of-direction drills also referred to as agility drills, were used to measure this skill (Figure 2).

For this experiment, the Illinois Change of Direction Test (ICODT) was utilized to measure participant's ability to rapidly change the direction of their movements. The ICODT has

been shown to have high absolute reliability, which was assessed by Hachana et al., based on its intercorrelation coefficient (ICC= .94) and standard of error measurement (SEM= 1.24%) (Hachana et al., 2014). These scores indicate that the test can produce consistent results throughout multiple testing samples. In addition to agility, lower body power output is a vital component in most sports. Using a broad jump has been seen in literature as a valid test to assess lower extremity power output (Krishnan et al., 2017).

When individuals exercise, they often listen to fast pace music. In this study, 96-130 BPM was the range of song tempos used by the participants. The smallest BPM used would classify as allegretto meaning moderately fast-paced while the upper range falls more under allegro referring to a fast-paced or quick tempo (Masterclass, 2019). This study required participants to perform to the best of their ability, and listening to faster-paced music, hypothetically, allowed them to achieve optimal arousal.

### **Procedure**

Completion of the warmup was done before doing any exercise. A proper warmup can reduce the chance of injury by increasing the body's core and tissue temperature and increasing the joint's range of motion (ROM), allowing them to move through the appropriate ranges during the session (Shellock & Prentice, 1985). Priming the body for the desired movements can also allow for the best performance possible (Shellock & Prentice, 1985). This is typically done by breaking down and completing portions of the primary motion during the warmup.

### **Warmup before completing the performance drills**

1. *2-minute jog around the track or long length of the gym*
2. *High knees 10yds*
3. *Butt kickers 10yds*
4. *High skips 20yds*
5. *Karaoke 10yds switch sides and repeat*
6. *Lunge with twist*
7. *Over-under the line step 10 yds switch sides and repeat*
8. *Sweep the floor (hamstring stretch)*
9. *Gradual sprints 50-75-100% down and back, short side*

The functional tests were implemented once the warmup was completed. Participants were allowed a total of three trials with each test and an average of 90sec-2minutes rest in between attempts. Participants should've be fully recovered for each attempt, so fatigue from the previous run wouldn't affect their results.

The initial trial was for the participants to gain familiarity with the test. The second trial was the baseline test to see how well they could perform without music. Participants played their music of choice, if it met the minimum tempo requirement, during the last trial attempt.

## Results

A Paired-Samples T-Test was ran using the results from the participant's trials. The purpose of this test was to gather quantitative data. The mean values produced compare attempts in the non-music trial to attempts in the music trial. With a value of  $-0.0994$  meters, non-music attempts were on average  $0.0994$  meters (about 4 inches) less than attempts in the music trial. (Table 1). The test used an alpha value of  $.05$  while using the 95% confidence interval. Data with p-values less than the alpha of  $.05$  would be yield a significant results. The tails of the distribution are cut at 2.5% meaning surpassing this threshold strengthens the significance of the data. The Paired-Samples T-Test also produced a  $0.001$  p-value for the broad jump and a  $0.002$  p-value for the ICODT (Table 2). Production of a p-value less than  $0.05$  means that the null hypothesis is rejected, and the smaller the value the stronger the evidence for rejection (Beers, 2021). The null hypothesis is that 'music does not have any effect on the performance of the ICODT and broad jump'. Therefore, evidence for rejecting the null hypothesis is strong with p-values of  $0.001$  and  $0.002$ .

## Limitations

Conducting this study during a pandemic created several limitations. Many of which made the data collection process more difficult. Due to government-mandated shut-downs, data collection was moved to the fall 2020 semester due to lack of facility access. Additionally, due to prior commitments, scheduling was an issue as well. The fall semester is typically the busiest for athletics and as a result, the Athletic Training staff and students had their hands full.

Injuries within sports are difficult for athletes when participating in their sport. As part of the athletic training team, we take many measures to get them back to practice as soon as we deem reasonable. This might mean providing taping to restrict movement or hold them from participation to complete rehab for injuries. The only disqualification of this study was those dealing with injuries at the time of the study. There were many injuries this past year that occurred for a variety of reasons. These injuries didn't restrict participation completely, however, as an uncertified Athletic training student, the lead researcher was unable to implement the preventative taping techniques that kept many in their sport, during data collection. Additionally, most participants were recruited from athletics resulting in a drastic loss in potential participation. Lack of participation limited the potential power of the study as well, making the results less reliable.

## Discussion

Functional tests, like the ones used in this study, are more specific to athletic skills than other tests used in previously conducted studies (Atan, 2013; Pujol & Langenfeld, 1999). The data becomes more accurate as the testing methods mimic the motions used in a sport more.

The mind-body connection is powerful. Even in research regarding pharmaceutical drugs, this connection has been shown to have a significant effect on participant outcomes (Miller & Rosenstein, 2006). Some people have experienced and believe that music facilitates performance. Participants potentially performed worse due to anticipating this change.

The mind-body connection is powerful and can be utilized by anyone to improve their performance. This can be seen within the biopsychosocial model. This model explains the connection between an individual's psychology, physiology or biology, and social life (Alonso, 2004). Each piece of this model plays a role and can affect the others. During athletic performance becoming nervous and increasing anxiety based on this model can thus impact performance. Again, under this model, believing a tool could impact performance will ultimately alter the biology, regardless of it having direct changes on the psychology or social wellness.

The application of this research in a more specific setting could be a good next step. Setting such as with athletes before an athletic event. Competition is ultimately what athletes train for and is typically when the greatest injuries occur. Implementing music with preferred songs before athletic events might allow for greater optimization of arousal compared to listening to music via speaker as some teams do doing their pre-game ritual. For some, the social aspect, in addition to the music altering the psychological state, might provide even greater benefit than just listening alone. Implementing these ideas and testing outcomes such as injury rates, or taking a mental wellness questionnaire, are just a few directions that this research project could turn.

### **Conclusion**

To achieve optimal arousal, athletes need to have as much control over their emotions as possible. Many different neurotransmitters affect arousal and finding an appropriate balance can create a better internal environment for performance. Music can influence these variables, and as this study shows, allows for closer to optimal arousal levels. Music can also regulate how some of our body systems function. The tempo of music can set the tone for the body and increase the metabolic rates of several internal systems. Music has a positive effect on arousal when used appropriately for emotional control and autonomic nervous system efficiency. However, if the body becomes overwhelmed or underwhelmed, music may not positively affect performance.

Perception is critical to exercise performance due to the various physiological changes that can occur. By altering the brain's perception of high-intensity exercise, one can impact performance, whether its movement quality, less time taken to finish an exercise, or even more power output. How the brain perceives a stimulus will determine the changes in bodily function that occur. Listening to music can decrease the rate at which negative stimuli, created by strenuous exercise, are interpreted by applying a positive or pleasurable one, like music.

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## **Perceptions of Hearing Students Towards Deaf People: A Change Within Education**

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### **Abstract**

Schools within the United States have been slowly adding American Sign Language (ASL) to their curriculum as an option for a foreign language credit. ASL is ranked as the 3rd most used language in the United States (Lee & Scott, 2018). The purpose of this study is finding what perceptions hearing people have about deaf people and determining if previous perceptions change once receiving education about the population. I examined if hearing students' perceptions of Deaf people change before and after taking an American Sign Language 1 course with an online pre- and posttest survey sent to students at the beginning and end of the semester. My hypothesis was hearing students' perceived knowledge of Deaf people and their culture would positively increase showing better understanding of deaf people compared to their perceptions before taking ASL1.

Within my findings, 38 participants completed the surveys. I discovered hearing students' perceptions of Deaf people and their culture positively increased after completing ASL 1 courses.

## **Perceptions of hearing students towards Deaf people: A change within education**

Peoples' perceptions change every single day, whether it be looking at jobs, beliefs, cultures, careers, etc. Major effects of one's perception revolve around their culture and who is included in that culture. How people perceive one another depends on their own culture and how they choose to view others. If people are viewing individual's culture from an autonomic perspective, they are comparing their own culture to someone else's culture, therefore subconsciously making assumptions about the individual. According to the Sociology Dictionary, cultural relativism is defined as, "The view that a culture can only be understood and judge by the standards, behaviors, norms, and values within the culture and not by anything else." If someone chooses a cultural relativism approach, the person is recognizing the difference in both cultures and may allow for an open perspective on the opposing culture.

The purpose of this literature is comparing both positive and negative aspects from perceptions of hearing and Deaf people towards one another. Focusing within the education system, I explored merging American Sign Language (ASL) and Deaf culture classes within hearing public schools. The goal of this study was determining what perceptions hearing people have about Deaf people and understanding how those perceptions and knowledge had changed over time.

Within the literature, I wanted to highlight the importance of labeling between "Deaf" and "deaf." In the text, I may refer to people who have either completely lost their hearing, are hard of hearing, or was born without being able to hear as "deaf" or "Deaf." The capitol 'D' in "Deaf" is used to describe people who identify themselves as culturally Deaf. These individuals actively use sign language, interact frequently within the Deaf community, and are ultimately proud of being Deaf. Whereas the lowercase 'd' in "deaf" refers to having total or partial hearing loss.

### **Literature Review**

Both hearing students and Deaf students have different perceptions of one another. Typically, these differences arise from having an extremely different lifestyle and upbringings simply because deaf people are minority groups within a hearing society (Vernon, M., Andrews, & Jean F., 1990). Integrating these two worlds within a school system has its pros and cons. A positive outcome of integrating both hearing and Deaf people is the opportunity to better connect, communicate, and understand each other's lives. However, many municipal areas do not have necessities for Deaf people to succeed within a hearing school such as long-term interpreters (Lee, C., & Pott, S. A., 2018).

A study conducted by Brown & Foster (1991) integrated hearing students with Deaf students at a collegiate level. The study focused on both the hearing and deaf perceptions of one another. The researchers learned perceptions of each side had both negative and

positive perceptions. Researchers found there was not a significant correlation between negative perceptions of both parties while being educated within the same space. On the other hand, there was a significant difference in perceptions when focused on social constructs. Hearing students had more negative perceptions of Deaf people for social aspects (e.g. communication, social cues, noise, etc.). Either they did not know how to talk to deaf students and became frustrated or found deaf students' social skills less respectful due to being too loud while others were trying to study (Brown & Foster, 1991). Socially being too loud may occur from the inability of hearing themselves as they are communicating to one another or from playing music too loudly in order to feel the vibrations of the songs. The hearing students suggested implementing more ASL and Deaf culture classes, allowing them to learn how to communicate and understand one another on a more social level (Brown & Foster, 1991). This is important within the study to understand the implications of why hearing students and deaf students are not integrated as much within public school systems.

When hearing students are united with deaf students, they are able to connect and learn more about one another. A research study by Bowen (2008) included enrolling deaf and hearing children within the same classes to see their perceptions of one another. The researchers found hearing students who had the most negative comments about their deaf peers also had the worst signing skills (Bowen, 2008). This may correlate to the small rates of intersectionality between both hearing and deaf worlds due to lack of communication within both languages. It is difficult to gain connections with others if people are not able to communicate with each other. This enhances to the research by exemplifying the language barrier that many hearing people have with deaf individuals and the importance of having ASL classes within a hearing education.

A study conducted by Suzanne Reading and Robert J. Padgett (2011) focused on the connection between service learning and American Sign Language instruction. Within this study, the Deaf community served as communication partners with college-aged hearing students. Together, they did service-learning projects along with students learning the language of ASL. The study showed hearing students who participated in service-learning experiences with the Deaf community was advantageous to their perceptions of the minority population. The undergraduates had more connections within the Deaf community by gaining ASL instructions and learning about the culture as well (Reading, S., & Padgett, R., 2011). This is important for research in order to understand the positive change in perceptions of hearing people towards Deaf people and their culture once they are integrated and can interact with one another.

Schooling in the United States have been adding ASL courses to their curriculum as an option for a foreign language credit. Currently, ASL is ranked as the third most used language in the United States (Lee & Scott, 2018). Then why doesn't the United States offer ASL classes within every high school? Without the knowledge of the culture and language, hearing people will not be able to learn or understand deaf people and the hearing culture will continue to result in negative perceptions throughout time.

I wanted to further explore if hearing students' perceived perceptions of Deaf people change after taking an ASL 1 course. Unfortunately, findings displayed there were not many previously conducted studies focusing on hearing students' perceptions of Deaf people and their culture. Many of these studies focused on adolescent deaf students integrating themselves within a hearing school (Brown & Foster 1991). Typically, these studies were conducted by Gallaudet University, the only Deaf university within the United States. With this information, the I decided to conduct a study focusing on hearing students' own perceived knowledge.

## **Methods**

### **Participants**

A total of 38 participants completed both the pre- and post-test surveys. Students were enrolled in an American Sign Language 1 class at one Midwest University. The population demographic consisted completely of college-aged students with 34 females and 4 males. Majors varied across the sample, but 13 students were majoring in Communication and Science Disorders.

### **Procedure**

A pre- and post-test online Qualtrics survey was sent out to students in an American Sign Language 1 class to assess their perceptions towards deaf people. This research had approval from the formal Institutional Review Board (IRB) to ensure the ethicality of the study. The questionnaires asked students perceived perceptions of their own knowledge of Deaf people, Deaf culture, American Sign Language, and background knowledge of these topics prior to taking ASL 1. I also asked about the student's background knowledge about deaf people along with demographic questions (e.g. age, race/ethnicity, gender, etc.).

Both the pre-and post-Qualtrics surveys had the same questions, allowing to completely determine which part of the students' perceptions had changed over the course of a semester. Participants chose whether they wanted to answer the survey on their own accord. Upon completion of the surveys, I assumed the participants had given consent to participating within the study, which was stated within the cover letter before the survey began.

To determine hearing students' perceptions of deaf people, I implemented three main variables understanding students' own perceived knowledge of Deaf people, Deaf culture, and American Sign language. The students' answers for these specific questions were determined by a 5-point scale: 1 being the least amount of perceived knowledge and 5 being the most amount of perceived knowledge. Example items for perceived knowledge of Deaf people included, "To what extent was your knowledge of Deaf people?" and "Does every Deaf person in the world use American Sign Language?" Examples of questions focused on the variable knowledge of Deaf culture included, "To

what extent is your knowledge on cochlear implants?” and “Do you consider a Deaf person as “disabled?” Example questions asked about American Sign Language were phrased, “Is it important to use facial expressions when signing?” and “How comfortable do you feel signing to a Deaf person?”

The hypothesis was the hearing students' perceived perception of Deaf people, their culture, and ASL will positively increase after taking an American Sign Language 1 course. This allows the students to better understand how Deaf people communicate and their lifestyle compared to before they had taken the course.

## **Results**

To determine hearing students' perceived knowledge, I utilized a paired-samples t-test for each variable on the software Statistical Package for the Social Sciences (SPSS) comparing the difference of students' own perceptions before and after completing an ASL course with the data received. The main outcome variables were the students' perceptions of their knowledge of Deaf people, Deaf culture, and ASL.

### **Knowledge of Deaf People**

The first variable I analyzed was the students' knowledge of Deaf people. The goal was determining the change in perception of this variable to detect if the student's perception increased in knowledge, resulting in a better understanding of the minority population. The finding was statistically significant:  $t(37) = 17.40, p < .001$ . The results showed a pre-test mean score of 2.05 and a post-test mean score of 3.32 out of 5 possible points with a standard deviation of .38. Comparing these two mean scores, the post-test score is higher than the original pre-test score, meaning the hearing students' perceived perception of Deaf people had positively increased to better understand the population. Please see Figure 1.

### **Knowledge of Deaf Culture**

The aim of this variable was determining how learning about Deaf culture and the mechanisms Deaf people use to interact within the hearing world (e.g. communicating with hearing people by writing down words) would influence a student's perception on Deaf culture. The finding was statistically significant:  $t(37) = 18.9, p < .001$ . The pre-test mean score being 1.68 and the post-test score was 3.24 with a standard deviation of .40. This assisted me in discovering the student's perceived knowledge of Deaf culture and how it may have influenced their perception of Deaf people after completing an ASL 1 course. Please see Figure 2.

### **Knowledge of American Sign Language**

Lastly, the analyzation of hearing students' perceived knowledge of American Sign Language. With this variable, I determined the capacity of learned information from the class about the language. Once completing the analyzation for this data, I understood

the student's comfortableness of communicating with a Deaf person. The results of knowledge on ASL was statistically significant:  $t(37) = 20.3, p < .001$ . The mean score for the pre-test was 1.74 on a scale of 5 with the post-test mean score being 2.87 along with a standard deviation of .38. Therefore, this data showed that participants felt more knowledgeable about ASL after the semester compared to the beginning of the semester. Please see Figure 3.

## **Conclusion**

In this study, I anticipated finding a change of students' perceived perceptions on their knowledge of Deaf people, Deaf Culture, and American Sign Language. Since these are the biggest topics taught within the course, the hypothesis predicted the scores would have the most significant change within students' perceived perceptions.

The findings supported the hypothesis hearing students' perceived perceptions of Deaf people and their culture would positively increase after taking ASL 1 to better understand how Deaf people communicate compared to before they had taken the course. Each variable was significant within the tests, discovering that students' perceived knowledge on each variable increased after completing an ASL 1 course.

With this information, I anticipate having evidence showing surrounding high schools the importance of adding ASL courses into their school curriculums. There are many high schools within the midwestern states who do not offer American Sign Language courses within their school programs. I wondered why, considering many individuals are constantly surrounded by Deaf or hard of hearing people. Deaf and hard of hearing people have occupations within customer service industries, different schools, medical industries, etc. People are constantly encountering Deaf people and many hearing individuals are not able to serve them or even remotely communicate with them. The data from this research may convey to intermediate schools how imperative it is to have American Sign Language courses within their curriculum in order to immerse the hearing world with the Deaf world.

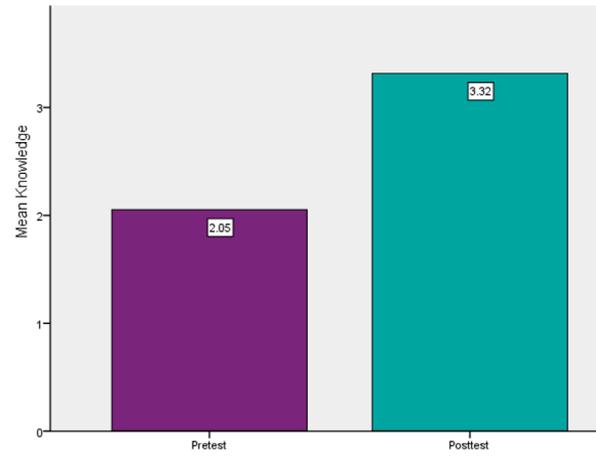


Figure 1 Student's average reported knowledge of Deaf people

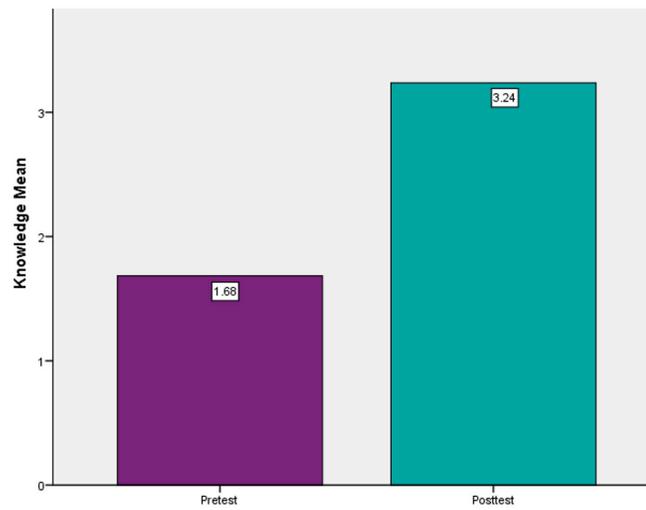


Figure 2 Students' average reported knowledge of Deaf culture

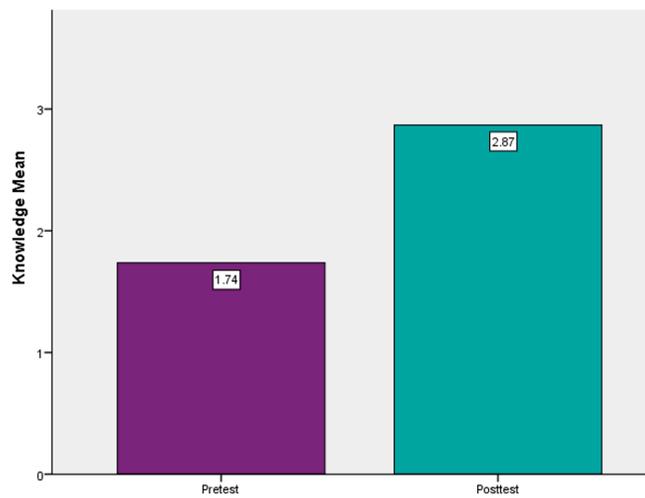


Figure 3 Students' average reported knowledge of ASL

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## Analyzing Parasite: Abstract Meaning within Emblematic Framing

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In 2019, South Korean director Bong Joon Ho shared his blockbuster take on what it means to be a human parasite during the 21st century. Focusing on economic inequality, *Parasite* tackles the ever-growing divide between the upper and lower classes in the modern capitalist system. Featuring an all-star cast in front and behind the camera, the film went on to become South Korea's highest grossing film of all time and even influenced federal politics within the country.

### **Abstract**

Film is a unique source of storytelling, one which allows stories that evoke empathy to be shared among the masses. It displays the power of narrative and transcends the fictional world with real-world implications. Bong Joon Ho's *Parasite* has received universal praise for its presentation of classism among contemporary South Koreans. *Parasite* showcases the universal concept of class division through different filmmaking techniques and Ho's craftsmanship won the film four Oscars, including a historical win for the 2020 Best Picture, the first foreign film to do so. As the first foreign film to ever win Best Picture, *Parasite* has opened the door for foreign filmmakers at the Academy and paved a path for more diverse, socially conscious stories to be told in the American market. Based on my analysis of the film's success, *Parasite* has the potential to open doors in and outside of the film industry, including new opportunities for foreign filmmakers to a modern housing reform in South Korea.

In order to fully understand the scale of *Parasite*'s impact, we need to dive deeper into the film's content first. *Parasite* tells the tale of a lower-class family (the Kim's) slowly making their way into an upper-class family's (the Parks) life. In this movie, the Kim family begins to work for the Park family one-by-one until the entire household is employed by the Park's. The subtle and not so subtle narrative showcases the differences between the poor and the elite, resulting in a bloody finale between the opposing classes. Of course, there is so much more to the narrative than this, but for the sake of time and

space, I will assume that the reader has already viewed the film. In case the reader has not, I will summarize appropriate scenes and details when necessary.

### **Literature Review**

Parasite was of course the main focus of our research. Director interviews were also incorporated into the study, adding direct input from the film's creator. The reviews of credited film critics were considered as well, which gave unique viewpoints on different scenes. Other sources included ethical theory from Franz Fanon, Sigmund Freud, and others. Additional textbooks were consulted for literature criticism theory and review. Film theorists and makers were also included, such as Gustavo Mercado and Alfred Hitchcock, to give an industry perspective on the work.

### **Methodology**

An initial viewing of Parasite was conducted without previous research considered, just to get a feel for the film and understand it at an audience level. Next, I found relative articles that critiqued the film and expanded on the plot's narrative. I then reviewed film theory that I thought Parasite utilized particularly well and compared it to ethical theory. The comparison led to the conclusion that Bong Joon Ho displayed ethical and post-colonialism theory using different filmmaking and narrative techniques. Lastly, I researched the success Parasite had gained leading up and following the Oscars and studied how the film affected the movie industry and beyond.

### **Results/Findings**

Parasite tells the tale of class division among South Koreans from a pessimistic perspective, holding nothing back against the upper class as the poor protagonists struggle through the narrative. Here is an analysis I conducted of a few different pivotal scenes from the film:

Parasite tells the tale of a lower-class family, the Kim's, slowly making their way into an upper-class family, the Park's, life. In this movie, the Kim family begins to work for the Park family one-by-one until the entire household is employed by the Park's. The subtle and not so subtle narrative showcases the differences between the poor and the elite and results in a bloody finale between the opposing classes.

Parasite is riddled with Emblematic Shots throughout its entire 2 hour and 12-minute run time. Gustavo Mercado, author of *The Filmmaker's Eye*, defines emblematic shots as powerful, abstract shots that can almost "tell a story" with a single frame. The example he uses in the book is Luke Skywalker looking towards the double suns setting on the Tatooine horizon. Generally, a character looking towards the horizon is a movie trope that signifies hope and looking towards the future. He will later use this trope to subvert the audience. These emblematic shots encourage people to look deeper into the film, and Bong Joon Ho utilizes this technique to really emphasize the personalities of his characters in Parasite. I grabbed four emblematic shots from the film that really stood

out to me and used them on my poster here, which was pretty difficult to do, because this film was loaded with abstract cinematography, to the point where entire scenes felt emblematic. For example, one shot that is repeatedly shown throughout the film is of a rock that is given to protagonist Ki-Woo. Ki-Woo says again and again that things are “so metaphorical,” including the rock. I think that’s Bong Joon Ho’s sense of humor creeping through by poking fun at people who over-analyze films, like myself. Anyway, this rock follows Ki-Woo throughout the film, and at one point he even says that the rock is a part of him. It is only in the final moments of the film that we see him place the rock in the river and ascend from poverty. Bong Joon Ho frames this rock in the film using Hitchcock’s rule, which implies that the bigger the object in a frame, the more importance it carries in the film’s narrative. Ho frames this object multiple times throughout the film, but always in the same style, center framed. This abstract shot implies the importance and connection the rock has to the Kim family and, as I said before, only once its removed from the family do the Kim’s go free from their lower-class shackles.

In the opening scenes of the film, we see the Kim family’s housing situation, which isn’t really a house, but instead a basement-apartment. Already Bong Joon Ho is framing the Kim family as a literal lower class, living beneath the streets of the city in a cold, dark basement. The family is so impoverished that they can’t afford their own phone and Wi-Fi bills, so they leech off other networks, which they can only do from their bathroom, to check their emails for job applications. Immediately, Ho shows the audience the unattractive lifestyle the Kim family is forced to live in, scurrying around their basement home like insects and leeching off others.

Another key emblematic shot is when Ki-Woo is first introduced the Park family. Bong Joon Ho sets up the scene so that the audience is already subconsciously dividing the rich from the poor. In the shot included on the poster, the glass walls literally divide the poor from the rich, with Ki-Woo and the housekeeper on one side and the Park mother on the other. The composition of the scene isn’t the only thing that frames the differences between the rich and poor, as even the costume design emphasizes the contrast between the two classes, with the poor wearing dark, bleak colors such as brown and black while the elite are sleeping comfortably, dressed in an all-white, perfect dress. One could even analyze further to say that the composition is off balanced, with the poor doubling in population compared to the rich minority.

The third frame selected emphasizes the struggle of the lower class. In this scene, the Kim clan fights the former housekeeper and her husband over a cellphone that contains a video of the Kim family caught in a lie. The luxurious lifestyle the Kim family has acquired has turned them against the other lower-class family, to the point where they end up killing their “neighbor in need.” After taking a closer look, the viewer may realize that the families are fighting over nothing but a job, a job where they are still in servitude to the rich, highlighting just how money-crazed and desperate the unfortunate lower-class can be at times.

The final shot analyzed was the frame of the Kim family returning home after their dispute with the former housekeeper. After an unexpected storm comes and “ruins” the Park family’s camping trip, the Kim’s are forced to leave their dream lifestyle and descend back to their basement housing reality. I particularly enjoyed this scene because Bong Joon Ho really draws out the walk home, putting emphasis on how far away the poor Kim family is to the literal upper-class Park family.

Upon reaching their home, the Kim’s discover that their apartment has been flooded and they’re forced to evacuate, grabbing only what they can carry in their arms. Waist high in sewage and stormwater, the Kim’s are forced to stay in a shelter for the night, only to be called back to work by the Park family. The following scenes build up to the climatic finale, with Bong Joon Ho throwing away the subtlety he had been utilizing throughout the first two acts. The scene opens with the Kim and Park family directly comparing their experiences, with Mrs. Park saying how horrible the rain was for ruining their trip, but then the next day being grateful for it as it cleared the smog in the city, while the Kim family lost all of their personal belongings to the storm and had to sleep in a shelter. The comparisons continue until finally the film reaches its climax. After the poor Kim daughter is murdered by the housekeeper’s husband in an act of revenge, the wealthy Park son begins to have a seizure. Mr. Park, seeing that his son needs to leave the scene, flips over the limp body of poor Mr. Kim’s daughter and grabs the car keys, but not before making a face of disgust of the smell of the poor. In an interview with *The Guardian*, Bong Joon Ho says “These [are the] moments where the basic respect you have for another human being is being shattered. Smell really reflects your life. It shows if you’re struggling, what kind of work you do. Even when you sense the smell of someone else, you don’t talk about it in the open, because it can be rude” (Lawless).

This is the breaking point for Mr. Kim, as he grabs the knife in a rage of fury and stabs Mr. Park, killing him. Realizing what he’s done, Mr. Kim goes into hiding in the Park family’s hidden basement bunker, forced to live out the rest of his days there. The house he once desired is now the prison in which he resides.

The final scenes wrap up the narrative quite well, with Ki-Woo saying that he had suffered permanent brain damage from an attack by the housekeeper’s husband, his sister had died, and his father had “gone missing.” The final moments of the film show Ki-Woo’s aspiration to save his father by saving money, attending college, getting a degree, obtaining a well-paying job, and then finally buying the Park family house and freeing his father from the bunker. In other words, the American dream.

And with that final scene, Bong Joon Ho’s message is clear: the rich are born rich, live rich, and will die rich, while the poor are born poor, struggle poor, and will die poor.

The finale tells the tale of a world where the poor, tired of fighting over the scraps of the wealthy, seek their revenge in a justified blood bath. Unfortunately, Bong Joon Ho

tells the story as if it were a true reflection to our current society, where the poor end up suffering the most in the end while the rich will go free, with nothing but a bad memory to show for it. The rich will move on, but the poor are left broken, separated, trapped in their lower-class hole in society, or even dead. Once again, the rich live rich, and the poor die poor.

The final scene where the son looks towards the horizon and dreams of buying the house to set his father free is just that. A dream. Bong Joon Ho uses this common film trope of looking into the horizon and being optimistic, but unlike Luke Skywalker, Ki-Woo lives in our real world. Although the film finishes with hope of economic equilibrium, Bong Joon Ho makes it clear that the final scene is nothing but a pipe dream in our money-driven society.

The film's massive critical and financial success has led to many innovations inside and outside the film industry. Our research has helped shape a discussion for what may be possible in the coming years for the film industry. Other outcomes include increased understandings of Parasite and how class is perceived in film. Parasite's success is not only a win for Korean filmmakers, but for the film industry as a whole – opening the doors for more foreign films to be accepted among the American audience and encouraging studio executives to take more risks on smaller, more human stories from diverse voices.

### **Discussion/Conclusion**

As I say in my poster, this movie was a huge success, both critically and financially. It became so popular that it sparked a government housing reform for sub-basement apartments in Korea, which I believe is incredible. The idea that a piece of art such as a movie can spark such change is amazing to me. Of course, this paper doesn't even begin to scratch the surface of all of the implications from Parasite and the greater film industry as a whole, but I believe that it is a good starting point to further research how the art we create reflects the values that we hold so dearly. I believe that we as a film industry have a personal responsibility to tell these stories of underrepresented groups, and if we're not telling them, then we as an audience must support these stories by going and watching and listening to the storytellers that are making these films. I believe that these past few years, with movements such as BLM, #OscarsSoWhite, the Me-Too movement, and now Parasite, have paved the way for a more diverse, inclusive film industry that will tell better, more original stories that are sure to pay off critically, financially, and socially.

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## **A Walk in Her Shoes: How Women of Color Navigate a Predominately White Institution**

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### **Abstract**

This study is aimed at understanding how Black and/or Latina undergraduate women successfully navigate a predominantly white institution. Using narrative inquiry methodology and Critical Race Theory, I collected the stories and voices of women attending the University of Wisconsin – Eau Claire that identify as Black and/or Latina ethnicity. Another purpose for this research is to successfully apply the narratives of these women, audio-recorded as ‘testimonies,’ to gain greater insight on how students adjust to an environment outside of their comfort-zones. This project also aimed to provide awareness to enhance the experiences of future students who sacrifice their culture in the pursuit of higher education. The methodological approach of this research was to record and analyze the narratives of women who are currently enrolled at a predominantly white institution and transcribe the interviews into official testimonies. Interview questions were structured around the participant’s opinions, values, feelings, background, and demographics to understand their personal experience and how it impacted their time at a predominately white institution. As a researcher, I hope to share a clear and comprehensible understanding of the obstacles these minority populations face while attending a predominantly white institution. The research project has four main objectives:

- To identify how Black and/or Latina women adapt to the institution’s environment.
- To discover the resources available & the resources desired for success.
- To identify if mentorship plays an important part in support and guidance.
- To identify the personal investment behind each student.

The four concrete values examined throughout this project consist of mentoring, community, personal investment, and involvement. Through the analyses of the collected testimonies correlations between the four values were examined in order to propose changes within predominantly white institutions or prove which methods and resources keep Black and/or Latina women feeling safe, comfortable, and appreciated while pursuing an undergraduate degree.

## **Background**

Students of color pursuing higher education have fought for decades to receive equality while attending predominantly white institutions. “Students of color” refers to groups of racial and ethnic minorities including Black, African American, Asian, Latinx, Chicana, Native American, etc., while the terms “underrepresented” or “targeted racial minority” refer to specific racial/ethnic groups that have been disadvantaged in higher education. These groups include African Americans, Hispanic/Latino(a)s, American Indians, etc.

In the article “Negotiating the Gaze and Learning the Hidden Curriculum,” J. Esposito explores the hidden curriculum within predominantly white institutions (PWIs) and examines how women of color encounter higher education’s unspoken norms and rules that reproduce positional social politics. In the article “Connection and Commitment,” K. Booker underscores key factors including accessibility and approachability, authentic instruction, spokesperson pressure, and microaggressions. Booker points to the importance of having engaged and connected professors inside and outside the classroom as this is a factor that greatly impacts Black students’ success at PWIs. Having access to faculty of color creates positive memories for students because faculty of color often provide safe spaces for students to express themselves, their opinions, and their feelings.

It is clear that the process of changing an institution’s values and beliefs to fulfill the needs of the underrepresented student population requires the institution to be aware of the struggles and issues within EDI. My project seeks to “listen” to female students of color to examine how to increase this awareness and propose meaningful institutional change. The challenges minorities face are hard to comprehend until we walk in their shoes and hear their stories.

## **Narrative Inquiry & Critical Race Theory (CRT)**

This research study utilizes two methodologies, Critical Race Theory and narrative inquiry. The primary methodology used for this project was the narrative inquiry approach. This approach is the study of experience understood narratively, a way of thinking about, and studying experiences. Narrative Inquiry is a storytelling method used when collecting qualitative data. It highlights and amplifies the participant’s voices by focusing on their interpretation of their lived experiences. The second method used throughout this research paper is the Critical Race Theory. CRT is a theoretical framework that uses critical theory to examine society and culture as they relate to categorization of race, law, and power. It is also a theoretical and interpretive mode that focuses on the appearance of race/racism across dominant cultural modes of expression. CRT is a school of thought meant to emphasize the effects of race on one’s social standing. This study utilizes this lens as an attempt to understand how students of color are victims of systemic racism and how they are affected by cultural perceptions of race, microaggressions, and prejudice thoughts.

## Method

This research study consisted of collecting qualitative data on women of color studying at a predominately white institution within the University of Wisconsin System. Data was collected by recording the oral narratives of qualifying women who volunteered to participate in the study and transcribing the interviews into official testimonies for analysis. All participants must have been at a sophomore-level standing or higher, identified as a woman, identified as Black and/or identify with Latina ethnicity, and attended a university within the UW-System. Subjects were asked a series of 11 open-ended questions and had the freedom to share as much as they felt comfortable with. Interview questions were structured around the subject's opinions, values, feelings, background, and demographics. Pseudonyms were provided to keep subject's identity protected. Subjects were identified through multicultural organizations, Ronald McNair recruitment, and mentor connections. Subjects were recruited via email with an invitation for participation. A signed consent form was required in order to continue with the study. The benefit of participation in the research interview was being able to speak their voice, emotions, and thoughts in hopes to raise awareness of what it means to be an underrepresented woman at a predominately white institution.

## Four Narratives

In this section, I analyze the narratives of four Black and/or Latina women: Kelly, Daniela, Vicky, and Shaun. Every participant was asked to choose a respective name as their pseudonym to protect their identity. By interviewing a small number of Black/Latina women studying at a university within the UW-System, I was able to gather enough data to understand the campus environment for women of color. Interview questions were structured around the four concrete values of mentoring, community, personal investment, and involvement. Although their testimonies revealed all participants shared underlying similarities, each participant's experience was unique, and they had very different stories to tell. Participants shared the struggles they have had to overcome as a woman of color attending a predominately white institution. Using a Narrative Inquiry approach and Critical Race Theory lens, I present the stories of four brave participants.

**Kelly's Story** At the time of the interview, Kelly was 21 years old and going into her senior year at a university within the UW-System. She is from a predominately white town and identifies as a biracial Black and white woman. Kelly was raised by a single mother and grew up with six older siblings. During her childhood, Kelly described herself as a troubled kid that needed more structure. "We moved around a lot, so I know it was tough for me." Her attention quickly focused on sports after discovering her athletic abilities. "I put all my energy into sports and that's literally kind of like what made me, motivated me to stay in school and pursue a future in education."

"I grew up in a really small town. I was the only Black African American in my high school, so I would say I stood out. I am mixed so I'm not as dark but coming to [the university city], I knew it was going to be a predominantly white university, it didn't bug me because

I came from a predominately white town and my mom is white so I was kind of used to it.”

Attending a predominately white school was nothing new to Kelly, in fact, it was all she was used to. She struggled to find her identity during her childhood as she battled the confusion of what it meant to be bi-racial. I asked Kelly at what age/school year did she begin to recognize her identity, she responded with “Pretty late... probably sophomore year of high school.”

“I knew I always looked different, but my mom was like ‘oh you’re so beautiful, like that shouldn’t matter’ but also, when you’re the only one that looks how you look, it starts to get to you and (you) compare yourself to others. Like why do I have such curly hair? Why am I so much taller? Why do they look like this and that? In high school, that’s really when everyone started to point out my flaws.”

As a first-generation college student, she chose the university she attends because it was affordable and close to home. “I’m a first-generation student, I didn’t know if college was for me. Nobody in my family really went to college or was successful so I’m like ‘worse comes to worse, I’m an hour and a half away from home, I could drop out and get a job.’” Kelly had no expectations coming into her freshman year. She quickly adjusted to the new environment and was fascinated by her first Black professor during her sophomore year of college.

“He was my first Black professor ever. I feel like that’s when I started to really think ‘wow, there’s really no people of color (professors/faculty) or any role- models at the university to look up to.’ I expected to see bigger diversity, I didn’t really question it because of where I come from, a white town.”

Kelly utilized many academic and social resources during her time at her university. As a freshman, she was a part of a federal TRIO grant program designed to be an introduction to college that provides guidance and support for students to utilize. The program provides tutors, hosts events, and assigns a mentor to each freshman enrolled in the program. During the program, she met a lot of friends and even became a mentor after her first year. She also participated in a women of color student organization that hosted dinner and talks every semester. Kelly also discussed the challenges she faced as a woman of color at the University of Wisconsin-Eau Claire.

“I knew there would be challenges to face, especially being on your own. One of the biggest things is having honesty with myself. I am coming in... like I come from a pretty poor household, so I knew it was going to be on me. If I want to succeed, I know it is going to be by myself. Having no one that looks like you or can talk to you is very hard. “ One of Kelly’s biggest struggles was adjusting to the lack of representation on campus as well as the stereotypes and statistics provided to her. During her freshman year,

she was shown the average dropout rate for someone with similar characteristics that attended her university. “I feel like seeing it right away I was like ‘oh, like why am I even trying? Now I feel like it’s motivation because like knowing I am so close to graduating. I’ve doing so well; nobody is going to take me from finishing school.” Although Kelly has not taken any courses with a woman of color professor, she bonded with a Black male professor which has given her comfort and motivation to continue in her studies. He quickly earned her trust and became a mentor for her.

“He is such an inspiration and gives me motivation. He’s like one of the only professors that I feel comfortable even talking about personal stuff, like personal life and my personal struggles. He shares personal things with me, he’s the only one to reach out to me when racist on-campus incidents happen. None of my other professors have gone out their way to make (that) personal connection with me, you know. I feel like he’s amazing and he really cares for all students, especially students of color and supports them when we need it.”

One of the toughest questions I asked all participants was if they felt that they belonged at their university. By belong, I mean feel accepted as part of the institution and accepted by classmates and instructors. Kelly took some time to reflect of her answer.

“At the institution alone, I would say yes and no. I’m just another face going through, walking through, to get what I need to get done. I feel like I have done a lot to get myself out there and create meaningful connections. In my (major) department I feel very welcomed and belong there. But just like walking on campus, I still get anxiety, even as a senior, I get worried walking around campus. Are people going to stare, judge me, ask questions about me, stuff like that? In my (major department) I feel a lot more secure and safe than I do on campus. Maybe because I come from a small town or because I know it’s a predominately white campus and I don’t want to stand out or give the wrong impression, say the wrong things or just I don’t want to look different. I know you’re supposed to embrace your differences and stuff like that but also I’m a lot more comfortable when people know the real me.”

Kelly shared her own experience and struggles with the intention of motivating young first-generation women of color entering their undergraduate years. “Go out and get involved! It may seem scary, it may seem like nobody’s on your side, no one’s there for you, but with time you will find those people.” Being confident is essential. She expresses the importance of putting in hard work and effort in order to succeed.

“Don’t give up ever, whatever the statistics say, just keep doing you, keep focusing on you like your path will become apparent as you move on, just keep fighting for yourself. Believe in yourself, and don’t let anyone get in your way. Be confident.”

**Daniela's Story** Daniela was a 19-year-old sophomore in the College of Arts and Sciences at the time of the interview. Daniela grew up in a predominately white Minneapolis suburb with her two older sisters and identifies as coming from a blended family of Vietnamese, White, and Honduran. Growing up, she attended predominately white private schools that quickly made her realize she was unique from those around her. "It was an interesting area where I grew up when you are kind of the only one." Daniela shares the frustration she faced during her childhood.

"Something I have noticed now and have been navigating or unlearning, so to say, I feel like I grew up with a lot of internalized racism which is something I have been, it's been a process to unlearn. It's like you know when you are younger and all your peers around you... all your mentors, friends are white, you just want to fit in, you know. You do whatever you can to fit in with your friends' lifestyles. I think it kind of just came down to, like, rejecting my culture. I did not have an interest in learning Spanish, now I obviously do, but when I was younger, I was like 'no, none of my friends do this, why would I?' I would never invite my friends over. I would be so embarrassed if my parents showed up (to school events) and I did not want to associate with them."

Daniela was always aware of her cultural difference, even at a young age. "I mean I think I was always really aware of it, because how can you not be, you know? You're brown and everyone around you is white." Although she was always aware of her uniqueness, she did not embrace it until her sophomore year of high school.

"I'm brown and yeah, I don't look like everyone else, but that means I have better, sometimes bigger things to offer, you know? Like I said, it was a process of unlearning, it is something I still think about, I think about my childhood and all those things I did to fit in, I feel horrible about it. It's very uncomfortable and it's sad to think about that I rejected me- what made me and my family, I rejected it so much. I became more outspoken like with accepting who I am."

Daniela decided to attend her university because of the more affordable tuition and the first impression she got while touring the campus. She remembers the tour guide making a good argument for the school valuing social justice and inclusivity, something she is very passionate about. She was also looking for something different than her school, and a larger public university seemed like a good fit. As an undergraduate freshman, she quickly began to understand the campus environment.

"I feel like the university puts on a good front about valuing social justice and valuing inclusivity and I think they should and can be doing more for minorities but also the two rather large racist incidents, I think were handled very poorly and I don't know, it doesn't make for a good campus environment all the time."

She shared her frustration about being the only women of color in most of her classes. The expectations for students of color at a predominately white institution is an unspoken

norm that non-students of color do not understand.

“Something that I noticed... like right now I’m in a diversity in media class and I feel like I’m providing a lot of labor, you know? To just like explain people’s lived experience and be like ‘well this is how it affect me and people that identity as me’ and it’s like don’t mind it most of the time, but it’s like it’s very frustrating. For example, in my class if I wouldn’t say anything about whatever we may be discussing nobody else in the class is going to say anything, then they won’t learn about it.”

Daniela did not have many expectations of her university and was only looking forward to being in an environment where she could be academically focused. “I wasn’t really expecting anything because I was coming in without knowing anyone or knowing anyone that came before me. I was just going off the good vibes I got on the tour.” Daniela had a full year of experience as a student at her university before being interviewed for this research study.

As a freshman, Daniela was living on campus in the university dorm rooms. She expressed her frustration about girls in the building being openly racist and getting away with it.

“There was an issue where some girls on the floor that were just openly racist and very open about microaggressions and kind of just made their perspectives on students of color very clear and I feel like the RA (residence assistant) on that floor and the housing director did not handle it appropriately. The people that came forward (about the racist comments) ended up moving out the dorm because nothing was being fixed. I think it just makes you hypervigilant about the people that you’re around, like in your own dorm, the people you come across, like what are you thinking about me, you know? Not that it should matter that much what people think about me but I’m like ‘due to the color of my skin?’”

Although Daniela was only going into her second year at her university, she was already involved in school organizations such as progressive advocacy nonprofit and political action committee. She hasn’t reached out to any academic or social resources as she feels she does not need them yet. As a freshman, she attended student of color organization meetings but did not feel welcomed and felt excluded because she did not know anyone there. We move onto discussing any challenges that have occurred to her as a Woman of color.

“One thing I have noticed particularly with white men I’ve been in contact with is like an open fetishization of Woman of color, which is nasty, they are not people I’m friends with anymore. They would say things like ‘Can you say something sexy in Spanish?’ I don’t know, I’ve been asked that more than once and it’s shocking every single time. I think it comes down to like educating a lot of peers and things like that.”

As a student in the College of Arts and Sciences, Daniela believes her major is a more male-dominated department.

“I’ve had all male professors and it’s more intimidating to speak more in class. Sometimes you’re just very aware that you’re the only one, specifically woman of color, in the room so I can be very intimidated, but it’s just fine.”

Daniela has been lucky to have taken courses taught by women of color faculty. She was excited and scared, but in a good way, as she pushed herself to do particularly well in their courses. After meeting a woman of color faculty mentor in her department, she immediately called her mom to share the wonderful news.

“I thought it would be very cool to have a mentor that looks like me, you know. I think they can understand your experience more because it is also their lived experience and they understand the challenges you may face, they get it.”

Daniela believes she fights for her place at her university. Feeling like you belong at a predominately white institution can come with a lot of confusion and mixed emotions.

“Last year I went through a phase where I wanted to transfer (universities) but the way I look at it is, I think any institution in our society you are going to face issues with race. I’d rather help the environment for future students to come than for me to walk away. I don’t care if people don’t remember who I am, I just think there could be some changes to the environment on campus to make students of color feel like they belong and feel like their safe and feel like this institution was also made for them.”

For future generations of students of color attending a predominately white institution, Daniela believes they should prioritize finding a group of supportive friends to lean on when needed.

“Do not settle for friends who don’t understand, whether that means finding friends that look like you or friends that are educated and understand your experiences, but make sure you have something that you have to go back to for the days that are too much to handle.”

**Vicky’s Story** When the interview was conducted, Vicky was going into her senior year at a university within the UW-System. She identifies as a bi-racial woman of color and is a student-athlete. Coming from a diverse suburb in Illinois, she was immediately culture shocked when she arrived at her predominantly white institution.

“I didn’t really know I was a person of color until I came to this town. My hometown is really diverse and white people are definitely the minority. I don’t know, I just never really considered it an issue because it wasn’t really an issue and I think I’ve learned a lot more like why my skin color is important and why me being a person of color is important coming to college.”

Vicky was raised by a single mother, and she believes being raised by a white mother played a big part of her not understanding what it means to be a person of color. She experienced racism in high school, but she played it off more because there were so many other people that looked like her, making it easier to ignore. She recalls having a wonderful happy childhood and a good life growing up. "I've always known that I'm brown, but I guess I never really saw it problematic or the way society saw it until I got here." Coming from a diverse hometown helped Vicky gain a different perspective on society.

"I feel like I'm more open to a wider array of things because I have experienced so many different cultures, whereas some of my friends that grew up in a predominately white neighborhoods or white towns, they don't have that."

Vicky began to recognize her ethnicity/culture at a very young age, during preschool. A classmate did not want to play with her and her sister because "she was too dark." At such a young age, Vicky began to question her differences from those around her.

"I think that was the first time I really noticed... I didn't really get why, and my mom wasn't very good at explaining why, not that she did anything wrong, but I just don't think she could find the words." Reflecting on her freshman year of college, she shared her first racist incident at her institution.

"The first time I noticed it (racism) in a negative way was freshman year in one of my Latin American studies class, someone called me a mut. So, I think that was kind of the first time I was like... 'oh wow.' I just, I think I just knew that I was dark, I did not know that I was Black. I feel like I can't identify as white because I'm brown even though I am predominately white. I'm 50% White and I am 25% Mexican, and 25% Black so it's like... I can't because I'm brown, so I feel like I've always leaned towards that part of me. When I tell people that I'm 50% white like they often don't believe me which is just interesting to me, but I definitely feel like I lean more towards my Black side. I feel like just because I look that way but that's like I feel like I'm kind of forced to identify that way, the way that we structured race in society. Going back to me being 50% white, like I don't look white, so I feel like... I don't know, I kind of just have to be Black."

Vicky decided to attend her university for one main reason, to be a college athlete. She explains how she did not look into any specific program and knew very little about the university. "I knew nothing about the diversity, nothing about my major, like literally nothing about this school at all, I just didn't really care." Becoming a part of an athletic team that is predominately white was also a shock for Vicky.

"Honestly, I don't think I've ever (been a part of) a team that was predominately white. I get here and I'm the only person of color, so that's was like... I was shocked like I didn't even know what to say when I get to the first day. I definitely expected there to be more

people that look like me, but I think that was the first time I realized ‘Oh wow, this is not a diverse school.’”

Going into her fourth year at her predominately white institution, Vicky shared her experience so far.

“I feel like I just had to get used to it (the lack of diversity) and it’s definitely open me up to different situations and like I’m grateful for the experiences I’ve had and being able to deal with a place that’s not as diverse instead of like just going in the workforce and like expecting everything to be super diverse. There’s definitely been experiences that I wish I didn’t have to deal with it, but I mean that’s just like being a person of color. A lot of my friends from freshman year didn’t know what white privilege was and didn’t believe in it. Most of my friends are white so just kind of adjusting to that and like explaining it to them. I’ve never really had to explain my experiences to anyone until I got to college so learning how to kind of navigate that, it’s been interesting.

I thought I was doing a good job and now the world’s exploding and I’m realizing I still got work to do. I don’t want to (have that responsibility) but I feel like for most of them I am the only person of color they are friends with.”

Vicky was introduced to some academic/social resources during her first year of college but was quickly overwhelmed. Although she did not utilize them, she was always aware of the resources offered to multicultural students on campus. “I think I kind of rebelled against it because I didn’t really like the idea of, I don’t know how to put it, like it just kind of made me feel like a number. I was like ‘All these people are here to help you’ but like none of my friends had to do that so I don’t know, it’s kind of a source of frustration for me more than a source of like a place that I felt welcomed. We’re at a predominately white school so yeah, just shove all the people of color in this room and like make them be friends, you know. We don’t all like have to be friends because we are brown.”

Vicky faced many challenges as a woman of color at a predominately white institution, most of them happening in the classrooms. “Sharing my experiences has been a big source of frustration for me. Even in my(major) studies classes because I am the only woman of color or I’m part of a small group and I feel like often times it’s on us, which shouldn’t be.” When the topic of minorities is brought up in class, students often look at her. Most of Vicky’s frustrations have happened in the classroom but being a student-athlete at a predominately white institution has also come with challenges.

“I’ve definitely asked my coach like why there aren’t more people of color on our team and then he was just like ‘Well, this is like where I recruit’ and I’m like ‘Well, don’t you want to be more diverse?’ and he was like “Do you want me to go further and find less good athletes, not as good athletes to make the team more diverse or you want me to stay where I am at and keep recruiting white people?’ You can still look at good athletes, it can just be athletes of color.”

Vicky has been fortunate enough to have a woman of color advisor through her department. “It’s actually been pretty interesting; she definitely has a more diverse perspective. She’s Hispanic and I’m Hispanic and she’s a woman and I’m a woman and we get each other’s perspectives more.”

Being a woman of color at a predominately white institution has come with unspoken challenges for Vicky. She does not feel like she belongs at the predominately white institution because she stands out from the student population.

“Ever since the first day I got here I kind of felt like I stuck out for some reason. I kind of had a hard time identifying why because it’s not always in your face, you know. It’s like you’re brown but it’s kind of hard to forget when you’re just surrounded by people that don’t look like you. It’s not like I don’t feel welcomed, I do feel welcomed, and I love it here, but I can’t forget that I am a person of color no matter where I go. I think that’s why I don’t belong, it like it’s kind of just like my skin color is a constant reminder you know, and it’s like maybe that’s just my reckoning with race too in college. I can’t go back and unsee it, you know.”

For future students of color attending predominately white institutions, Vicky believes patience is key and setting boundaries is essential. “Be patient with yourself, you don’t have to tolerate if people are being racist or racially bias, you don’t have to take it.” Vicky also thinks allowing time to adjust is a major part of surviving a PWI. “I think the transition into college is hard, but the transition into an institution with not many students of color, you have to take race into consideration. I wish someone would’ve told me that because I was just in the state of shock, and I didn’t know how to prepare for it.”

**Shaun’s Story** At the time of the interview, Shaun was 21 years old and was going into her senior year at a university within the UW-System. She is from a diverse city in Illinois, comes from a single-parent household, has two other siblings, and is in the College of Arts and Sciences. Shaun identifies as Black, white, and Mexican.

“I don’t pick one over the other, It’s kind of hard because I’m not like super dark-skin, well not dark-skin, I’m obviously (of) color but I don’t look Mexican nor do I really look Black, so I don’t really consciously pick one over the other. I feel more Black just because I don’t look Mexican.”

Shaun’s hometown is much more diverse than the city where she attends school. “I think of it like the minorities (in her hometown) are actually the majority.” In middle and high school Shaun never had to pick out how many students of color were in the classroom. It wasn’t until college when she began to look for other students that looked like her.

“I would say I’m very lucky in the fact that that’s how I grew up. I got to interact with so many people. It wasn’t until I came to college where I would pick out like ‘there’s

another student of color.’ I’ve never had done that before and coming here I knew it was a predominately white institution and, in the beginning, I was like fine, and I still am with it. It’s given me opportunities to help learn about myself but also like teach others what it means to be a minority but at the same time, I had never been in the position where I had to teach others about what it means to be a minority.”

During her childhood, most of Shaun’s friends were white. It wasn’t until middle or high school, when she would have to fill out forms by herself and pick her race and ethnicity, that Shaun really began thinking of herself as a person of color. Although she began to accept her identity in middle and high school, Shaun began questioning it during kindergarten. One of Shaun’s classmates refused to play with her and her sister because of her skin tone. “I felt more like I had found an identity or part of my identity.” Shaun decided to continue her higher education journey at an institution within the UW-System because it was less expensive than other schools she was considering. “The campus is gorgeous, the people are super nice, let’s go here and we’re going to have a great experience. It was kind of more like the financial part of it than the diversity part that made my choice.” Before arriving to campus, Shaun had low expectations of the institution. During her freshman year, Shaun and her roommate did not socialize with other girls on their dorm-room floor, because they didn’t have much in common. Overall, her experiences have been pretty good. “I’ve had a lot of opportunities with finding research and classes. There’s no part that regrets coming here and choosing this university.” Finding a support group where Shaun could feel accepted and welcomed was essential.

“A huge thing for me, freshman year, was just like finding a group that I could be a part of, like I could, I guess, build a family with, maybe, if that makes sense, like build a sense of community. That for me was like finding different student organizations to be a part of. I found two (student organizations). They were more welcoming and open to everybody and there were people who looked like me, that was a huge thing, I was introduced to it through [a student organization event hosted every semester.]

Although Shaun concluded she hasn’t faced challenges for being a woman of color, she does struggle from imposter syndrome when it comes to presenting research. For the first time since she arrived to campus, Shaun felt like she belonged in her department when presenting her research at a symposium.

“After my research presentation, I sat there after I finished, and I was like ‘Oh my God’ it was the first time I’d actually felt real. I guess up until that point I finally felt just like somebody doing it and going through the motion. At that point I was like ‘This is who I am.’ Part of that was because, and this isn’t necessarily a bad reflection of the [major] department but we only have one woman of color in our department, so it’s kind of hard to see yourself [in that profession] when you don’t see people in your department who look like you. I wouldn’t say that I have challenges due to like, not having opportunities,

because I've had tons of opportunities, it's just more like there aren't people who look like me so how could I possibly succeed."

Shaun respects her department because they are aware, they need to increase the diversity within faculty. "I think their efforts in trying to diversify in general are genuine." Reflecting on the past three years, Shaun believed she finally felt a sense of belongingness as she was going into her senior year.

"I feel like I belong but it's like still like, I don't know, weird because I'll walk around campus and look up and see another person of color and be like 'Oh my God, there's more of us, this is weird.' So, that's still things I do, count how many of us there are in class. Overall, now I feel like I belong. Maybe not a year ago, but definitely not my freshman and sophomore year because I was still like 'I don't really know where I fit in.' I just hadn't found my community that I clicked with. It took me a while to find those (supportive people) and actually commit to doing it (student organizations) and realizing these people are here and like I want to stay here because of them. I hated it here for so long because I didn't have that community."

Shaun had a hard time finding her community through student of color organizations because she never felt like enough of the race or ethnicity. For future generations of students of color, Shaun believes getting involved is essential.

"Don't do what I did! Do it (join student organizations) because maybe you'll learn more. I would love to go back and do that and find friends that look like me and embrace more those parts of me. Be open to every opportunity you possibly can. Don't turn down opportunities because you feel like you don't belong. Just because you don't have people who look like you, doesn't mean you can't be the first person to do it and forge the way for other people to come after."

## **Discussion & Conclusion**

In this section I will focus on the four themes of the research project: mentoring, community, personal investment, and involvement as well as how participants illustrated the themes.

Mentoring can play a crucial role in a student of color's experience while attending a predominately white institution, which is why it is the most important theme. According to Seasons of a Man's life, mentoring contributed to the successful development of individuals and the mentors "support and facilitate the realization of the Dream." The "Dream" can be interpreted as the vision a young person has about the kind of life they want to have as an adult. Mentors can be guides for students of color that need additional support and encouragement, especially if do not have a support-system at home.

Kelly, the first participant, was fascinated with having a Black male professor for the first time in her life. She shortly realized the lack of diversity within faculty and staff at her predominately white institution. Kelly quickly bonded with this professor, as they shared a lot of similarities and understood each other. Her mentor is her inspiration and gives her motivation to continue working hard during her higher education journey. “He’s like one of the only professors that I feel comfortable even talking about personal stuff, like personal life and personal struggles.” Lack of representation in faculty members may lead to faculty of color taking on a lot of extra mentorship work that their white colleagues may not feel as obligated to do. The pressure to take on a mentorship role comes naturally as people of color feel the need to assist one another. Students of color feel safe, comfortable, and relate to people that look like them and share similar personal experiences. Having representation within faculty and staff is an important factor in student of color retention.

Another important theme is community. Community can be defined as a feeling with others, as a result of sharing common attitudes, interests, and goals. Having a healthy community for students of color can also enhance their experiences. Through communities, women of color can be themselves, find support, feel welcomed, and gain comfort while attending a predominately white institution. Shaun, our fourth participant, expressed the importance of finding a community where she felt she belonged. During her freshman year, she struggled to find a sense of belonging. After a couple years, she finally found a community that felt like family to her. Predominately white institutions often encourage students of color to become a part of diversity student organizations. Often times, students of color feel too pressured and become uncomfortable. For Shaun, she never found her community through student of color organizations because she felt she was never enough of the race or ethnicity to belong. For example, she did not feel as if she belonged in a Black student organization, or a Latinx student organization because of her biracial background. Shaun believes one of the main reasons why she did not transfer institutions is because she found her community.

The third theme that is highlighted throughout this research study is personal investment. Personal investment can be understood as an act of personal growth. While women of color navigate through a predominately white institution, they often face many challenges and obstacles that consists of facing fears and insecurities and transforming them into strengths. Investing in their selves takes personal willpower. This theme is different from the other three themes because personal investment is something that only you can do to enhance your experience. Daniela, our second participant, quickly began joining student organizations that aligned with her passions. Being a part of a progressive advocacy nonprofit and political action committee as only a second-year student enhanced her abilities to navigate a predominately white institution. As a freshman, Daniela admitted she wanted to transfer universities. She quickly included that any predominately white institution in our society was going to face issues in regards to race. She concluded that her mission was to assist in the improvement of the environment at her current institution

for future students of color. Daniela's personal investment in wanting to create a better campus for future generations is a journey that will not come easy.

The fourth theme of this research study is involvement. When focusing on the experiences of women of color at a predominately white institution, it is important to highlight their involvement on campus. Being emotionally and/or personally associated with someone or something can shape every student's experience in a unique way.

Throughout this study, it is important to recognize that involvement was only possible if the participants felt welcomed and comfortable. By providing a welcoming environment, students of color will feel safe to participate in on-campus events and organizations. All four participants share the commonality of being involved on campus with either support groups, student organizations, or athletics teams. Predominately white institutions can be intimidating for students of color, as they feel like a small number within a large white student population. Involvement of students of color is only possible if the campus provides them with safe environments to express themselves freely.

By analyzing the stories and experiences of these four women of color attending a predominately white institution, we can amplify the voices of other students of color. Even if universities have a small student of color population, these institutions should prioritize making them feel as if they mattered with welcoming and open arms. The journey can be draining and it can sometimes be impossible to see the finish line as a student of color.

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## **Cultural Competence: Understanding and Application by Health Care Professionals**

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### **Abstract**

This project aimed to increase the understanding of cultural competence in health care. According to U.S. Census predictions, around the year 2043, non-Hispanic Whites will drop below 50% of the U.S. population, illustrating an increase in racial diversity. Diversity is also increasing in many fields in terms of gender and sexual orientation as more efforts for equity and inclusion are being put forth. Cultural competence is essential to eliminate disparities and ensure quality care for minoritized individuals. Virtual interviews were conducted with 12 health care professionals. Semi-structured interview questions examined how these professionals define and apply cultural competence in their practices. Participants also reflected on their cultural competency training and available resources. Similar phrases used to define cultural competence included, “cultural knowledge”, “desire to learn and change”, “ongoing process”, and “individualized to the patient”. Common phrases used to describe applying cultural competence included “ask”, which was used in all 12 interviews, “acceptance”, “focus on social determinants of health (SDOH)”, “individualized”, and “staff collaboration”. Potential areas for improvement were revealed, including cultural competence education from Computer Based Trainings (CBTs) and in the hiring process, as well as transgender education. We hope this study provides knowledge of health care professionals’ understanding and application of cultural competence and will lead to improvements in health care facilities.

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## **Introduction**

Research on cultural competence can be applied to any discipline, but it can be life saving to study it in the health care field. By 2043, Non-Hispanic Whites will make up less than half of the U.S. population (Yen, 2013). This shows that the U.S. has a growing racially and ethnically diverse population that will be in need of health care services. Therefore, being culturally competent when caring for the community is essential in order to provide quality care for all. In the current U.S. health care system, racially and ethnically minoritized communities often face obstacles when accessing health care, such as language and communication barriers. These obstacles can compromise their quality of care. For example, African Americans and Hispanics are disproportionately burdened by chronic diseases (Collins et al, 2002). Understanding why certain populations may be more susceptible to these chronic diseases can help professionals improve the quality of care provided to these groups, and potentially eliminate health and health care disparities. In addition to racial and ethnic diversity in the U.S., there also is growing diversity in gender and sexual orientation. Both of these factors would be addressed with culturally competent care. Overall, the reasons given here demonstrate the necessity for research on cultural competency in the health care field. The ultimate goal of this project is to provide valuable knowledge of health care professionals' understanding and application of cultural competence that will hopefully lead to improvements in the administration of equitable health care.

## **Defining and Modeling Cultural Competence**

**Health Care Context** In a health care context, there are a variety of theorists that have contributed to the understanding of cultural competence.

A theorist in the nursing field is Madeleine Leininger, who defines culturally congruent care as:

Those cognitively based assistive, supportive, facilitative, or enabling acts or decisions that are tailor made to fit with individual, group, or institutional cultural values, beliefs, and lifeways in order to provide or support meaningful, beneficial, and satisfying health care or well-being services (Leininger, 1991, p. 49).

It is thought that culturally congruent care will lead to more favorable health outcomes and lower costs due to improved communication, better compliance with medical treatment plans, and reduced use of high cost services, such as emergency room visits (Schim et.

al., 2007). Leininger (2002) developed the Culture Care Theory, which remains one of the oldest, most holistic and comprehensive theories regarding this topic. This theory has many unique aspects that set it apart from other theories. It is focused on interlocking relationships between culture and care on well-being, health, illness, and death. Her theory is also the first nursing theory with a designed research method to fit the theory (Leininger, 2002). Throughout the development of Culture Care Theory, nurses faced the sizable challenge of identifying cultural meanings, practices, and beliefs that influence the perceived quality of care. These elements need to be understood for culturally competent care to be provided, and thus, the Sunrise Model (Fig. 1) was created. This model depicts factors that influence care and the interactions between them. It is frequently used by nurses for health care assessments. The model allows nurses to begin with a focus on whichever area they wish, either at the top or bottom of the model (Leininger, 2002). Overall, Culture Care Theory has been a significant contribution that adds to the understanding of cultural competence.

A more recent model of culturally congruent care was created as an extension of Leininger's work, adding in concrete examples and illustrations regarding application of the theory. This is known as the 3D Puzzle Model, (Schim et al., 2007, Fig. 2) which includes both a provider and client level. The provider level includes 4 main "pieces", or constructs: (1) cultural diversity, (2) cultural awareness, (3) cultural sensitivity, and (4) cultural competence (Schim et al., 2007, Fig. 3). Cultural diversity is omnipresent in today's global society, and diversity varies depending on the area in which care is being provided. Cultural awareness, on a base level, involves knowledge and recognition of certain racial, ethnic, and/or religious groups. However, there is significant intra-group variability, making it difficult to learn a set of facts about a particular group. Therefore, this model suggests that a provider should make inquiries regarding cultural practices on an individual basis. Cultural sensitivity refers to approaching the patient or community with humility and taking on the learner role rather than making assumptions of the individual or group. Finally, cultural competence, in this model, refers to the behaviors and actions taken in response to cultural diversity, awareness, and sensitivity. This 3D Puzzle Model reflects the nonlinear and interconnected nature of these constructs and suggests that all four pieces are necessary to achieve culturally congruent care (Schim et al., 2007).

As mentioned in other theories, an important process involved in providing culturally competent care is establishing self-awareness. Nursing professor Dr. Gloria Kersey-Matusiak (2013) provides the Staircase Model as an effort to identify one's own values and existing knowledge as a type of personal reflection. This model has the following "steps": Cultural Destructiveness, Cultural Incapacity, Cultural Blindness, Pre-Competency, Basic Cultural Competency, and Advanced Cultural Competency. At each step, there are different questions that should be used to determine where a provider places themselves, how they can increase self-awareness, and in what ways they can improve their cultural competence. This model differs from the Sunrise Model and the 3D Puzzle Model because it shows distinct steps, illustrating progression "up" the steps rather than ongoing development and shaping of cultural competence.

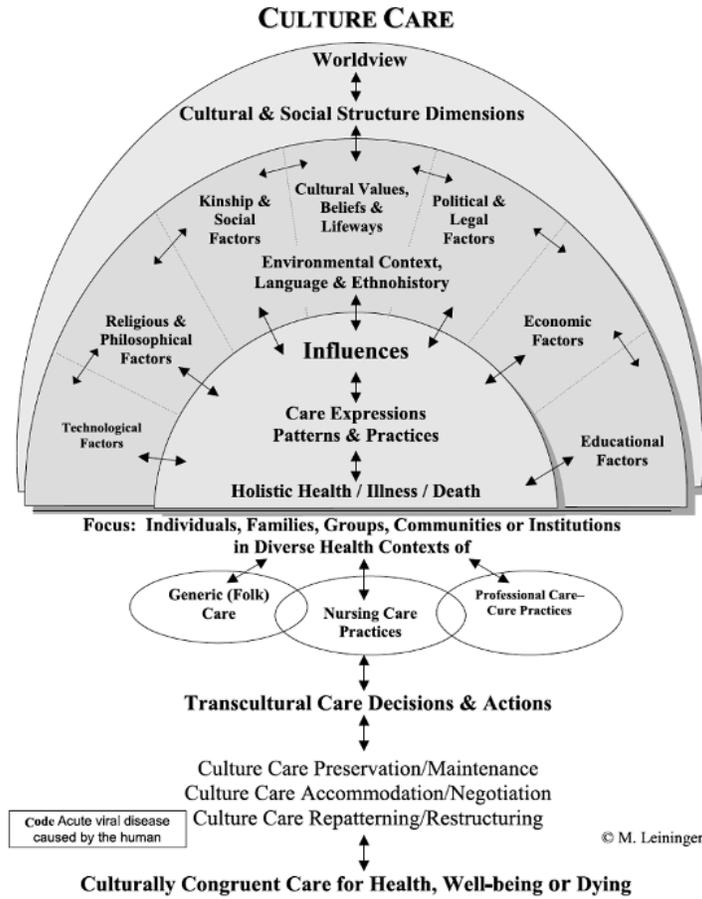


Figure 1: Sunrise Model.

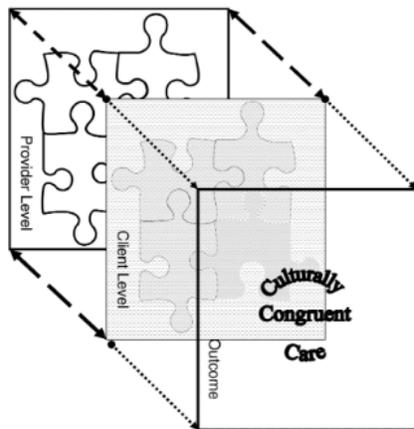


Figure 2: Culturally congruent care model.

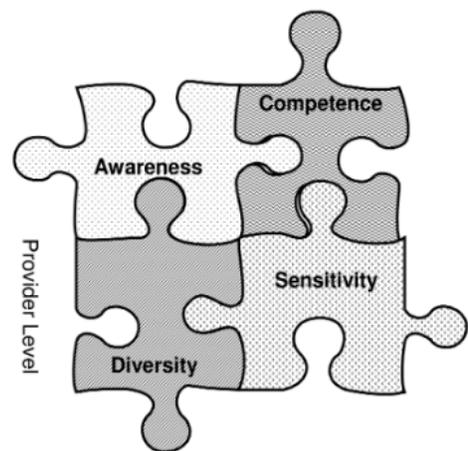


Figure 3: Provider level of culturally congruent model.

### **Current Interventions**

These theories have led to the creation of various interventions, each with the goal of improving cultural competence in the health care field. For example, many organizations are requiring their staff to undergo training related to diversity and care. A recent survey by the Institute for Diversity in Health Management (2013) shows that 81 percent of hospitals educate all clinical staff during orientation about how to address the unique cultural and linguistic factors affecting the care of diverse patients and communities, and 61 percent of hospitals require all employees to attend diversity training. Although this is a start, there is still room for improvement. Moving forward, it is important to recognize which interventions are available and how they can be utilized to improve cultural competency.

In a systematic review of culturally competent health care systems, the Task Force on Community Preventive Services evaluated five interventions that were designed to improve providers' cultural competence (Anderson et. al., 2003). These included; "programs to recruit and retain staff members who reflect the cultural diversity of the community served, use of interpreter services or bilingual providers for clients with limited English proficiency, cultural competency training for health care providers, use of linguistically and culturally appropriate health education materials, and culturally specific health care settings" (Anderson et. al., pg. 70). These interventions, variations of them, and others are often utilized to some degree within many health care facilities.

### **Guidelines and Standards**

In 1997, the Office of Minority Health developed a set of national standards to guide practices related to culturally and linguistically appropriate health services (Spector, 2017). These 15 standards, which have been improved over time, are called the National Standards for Culturally and Linguistically Appropriate Services (The National CLAS Standards, Appendix A). These standards set the bar for providing equitable health care in many federal and state agencies, as well as other national organizations. According to the U.S. Department of Health and Human Services (2018), they are intended to improve the quality of health care by creating a framework for organizations to serve increasingly diverse communities. Additionally, there are many organizations and groups that have developed other guidelines and initiatives to improve cultural competence. Some of these include the American Association of Critical-Care Nurses (AACN) Advisory Committee, Health Resources and Service Administration (HRSA), American Medical Association (AMA), WHO Network of Health Promoting Hospitals, American Hospital Association (AHA), and more. The guidelines and standards created by these organizations shape the practices of health care professionals in different ways, but with the same goal of improving care for minorities.

### **Training Workshops**

Another approach that has been taken to address this issue, is the use of cultural competency workshops. Each can vary in terms of what it includes and what its specific goals are. Multiple researchers suggest that effective workshops should educate providers about the role of cultural factors in influencing the outcome of patient-provider encounters (Khanna et al., 2009). These factors may include, but are not limited to: ethnomedical beliefs and the use of folk medicine, health beliefs, culturally prescribed values and norms, gender-specific status and roles, and religions. Understanding cultural factors allows the provider to better serve their patients. In 2009, a study was performed at Oregon State University, evaluating the outcomes of a specific cultural competency training workshop for health care professionals (Khanna et al., 2009). The workshop lasted 4 hours and focused on both knowledge and skills development. It did so through the incorporation of a traditional lecture component and a skills practice component, where participants would respond to health scenarios. The results of the study indicated that participants experienced a positive shift in their knowledge and skills pertaining to the provision of culturally competent health care (Khanna et al, 2009). This structure, involving both knowledge and skills-based training, may prove to be a good model for future training programs.

### **Additional Approaches**

Although training workshops can be an effective way to educate health care professionals on culturally competent health care, they are not the only option. At Advocate Lutheran General Hospital, one of the largest hospitals in the Chicago area, education on the importance and implications of cultural competence was added to new employee orientations. A diversity group was formed to organize cultural awareness days, which would allow staff to interact with culturally diverse community members. Local ethnic communities were surveyed to determine both potential barriers and opportunities for providing care specifically to the large South Asian population. This survey led to the creation of the first South Asian Cardiovascular Center in the Midwest, which was created to educate, screen, prevent, and treat South Asians for their high risk of cardiac disease (Health Research and Educational Trust, 2013). Another hospital that serves a very diverse population, Lutheran Medical Center in Brooklyn, also offers examples of innovative efforts. A cultural competence department, with a cultural initiatives coordinator and vice president of cultural competence, was created. The facility has multilingual and multicultural staff members, liaisons, and cultural advisory committees that interact directly with diverse community members. Hospital signage and health forms are provided in the five most common languages spoken in the community. Cultural competence training is required for hospital staff and medical residents. A Chinese unit exists to address specific cultural issues for Chinese patients. Both hospitals have shown great success as a result of their efforts (Health Research and Educational Trust, 2013). The intervention methods they developed could potentially be used as models for other hospitals and health care facilities in the future.

## **Methodology**

To investigate this topic, a qualitative case study approach was used. This was due to the project being more focused on gathering opinions and beliefs rather than numerical information. A case study was preferred in this situation in order to be as thorough as possible with one facility, rather than simply scratching the surface with multiple. According to Creswell (2012), dealing with a larger number of cases (sites) can become unwieldy and may result in superficial perspectives due to the amount of details reported for each site. A case study approach provides detailed descriptions and analyses that cannot be measured using a quantitative approach.

It was determined that health care professionals would be the most valuable participants for this study. Due to their direct interactions with patients, they can provide the most relevant information regarding cultural competence in health care. The pool of participants was limited to health care providers at one facility in two departments: Family Medicine and Obstetrics and Gynecology. These departments were selected because they would likely be able to provide the most diverse population of patients. Therefore, these providers would likely have more experience with applying cultural competence. To select participants, a letter containing the purpose, description, and expectations of the study was emailed to all health care employees in these two departments at the health care facility. Employees interested in participating in the study responded to a staff member at the facility and their name was recorded. A Qualtrics electronic consent form was then sent out to these individuals in which they consented to participate and be contacted to schedule an interview date and time. They included their contact information and their availability. Participants were then contacted via email and given five different dates and times to schedule an interview. All participants received a copy of their completed consent form. After an interview appointment was confirmed, a reminder email was sent 2-3 days before the interview date including tips to help the interview flow smoothly, interview instructions, and a Skype meeting link.

All interviews were completed virtually during the summer of 2020. In total, 12 interviews were conducted. Participants included: six physicians, two nurse midwives, one nurse practitioner, and three nurses. Five of these employees were within the Family Medicine department and seven were within Obstetrics and Gynecology.

The main interview questions that were asked are listed in Appendix B. These questions were semi-structured and open-ended, allowing participants to take their own direction, as encouraged by Seidman (2019). All participants were asked several identity questions to ensure that they were identified correctly when results were reported. These responses are shown in Table 1 in Appendix C along with other information about the participants. Other questions examined how health care professionals define and apply cultural competence in their practice. Participants also reflected on their cultural competency training and the availability of resources to improve cultural competence. Additional follow-up questions were asked depending on the topics that were brought up throughout the

interview. The order of the questions did vary between interviews in an attempt to make the conversation flow more smoothly and connect more with each participant. Everyone was offered the opportunity to review the final transcript of the interview to edit, add, or omit anything they wished. Due to COVID-19 and the inability to meet in person, these interviews were conducted via Skype, with two occurring over the phone, and one via Facetime due to technical difficulties. Each interview lasted less than an hour and was one-on-one with the participant. The Olympus Voice Recorder WS-8523 was used to record the audio. Within two days of the interview, the audio file from the interview was uploaded to the online program, Otter.ai. This program roughly transcribed the interview into a document which then underwent manual revisions while listening to the original audio file. Final transcripts were sent back to participants for review within 2-10 days of their interview. Materials collected included notes, recordings, transcripts, and facts about the health care facility and the community that it serves. All of the information that was collected was stored on OneDrive, the University of Wisconsin-Eau Claire's secured data system with two-factor authentication. Participant names were omitted in the final transcripts.

Analysis of the interviews was completed in three phases, with four interviews analyzed at each phase. The interview responses were color coded based on common topics that were discussed during the interview. Those codes were then compiled into a document based on common themes to more effectively analyze the results. Phrases or words that were expressed in two or more of the interviews were highlighted. Highlighted phrases or words from all 12 interviews were then recorded. Relevant phrases that were only present in one or two of the interviews were also recorded. Finally, all 12 interviews were analyzed together and a spreadsheet was created with these common and unique phrases to create a more complete picture of the topic.

## **Results**

Each participant shared a unique definition and application of cultural competence as well as descriptions of their previous and current cultural competence training. When interview responses were compared, several commonalities were revealed between participants, but a few key differences were revealed as well. In the charts below, the phrases that were most common among participant responses are towards the top of the chart, decreasing in frequency vertically down the chart. The most common phrases are included in the chart as well as several that were less common, but were necessary and important to have a complete understanding of the topic. The number of participants that used each phrase is on the far right side of each bar. However, these numbers do not indicate that any certain phrase or idea is more important than another.

## **Defining Cultural Competence**

Participant responses that were shared in relation to the definition of cultural competence are separated below based on certain themes. However, it is important to note that some participant responses do include more than one theme, creating some overlap.

Participants most frequently defined cultural competence as having cultural knowledge of different beliefs, customs, and values (Fig. 4).

“I think cultural competence means at least to have some basic knowledge of different cultures...” (Participant 1, personal communication, July 14, 2020).

“It’s being able to recognize the differences between the different cultural backgrounds with different populations of patients that we see” (Participant 2, personal communication, July 15, 2020).

“Cultural competence... is knowing about a culture’s way of speaking, their customs, their ways of doing things, routine, appropriateness, inappropriateness, things such as touch, talk” (Participant 5, personal communication, August 6, 2020).

“An understanding of different cultural needs and outlooks” (Participant 9, personal communication, August 13, 2020).

Some participants defined cultural competence more in terms of being culturally aware and recognizing that other cultures will differ from their own.

“I think cultural competence is just being aware and respectful of other cultures, that not everyone has the same upbringing and the same thoughts and feelings that you have, and so just that concept that you’re not always right” (Participant 7, personal communication, August 11, 2020).

“I would say that that [cultural competence] is the understanding that people come from different places in the world and due to that they have different exposures that may lead to them having thoughts, beliefs, or ideas that you aren’t familiar with” (Participant 11, personal communication, August 19, 2020).

“I would say that cultural competency lies in the awareness that there are a lot of different cultural perspectives and values and beliefs that are going to differ from mine” (Participant 12, personal communication, August 20, 2020).

Participants mentioned that it requires an active effort, an open mind, and a desire to learn about various cultures.

“...but to also be willing to keep learning from people, whether it be patients or friends or just anybody in the community” (Participant 1, personal communication, July 14, 2020).

“You have to research different things so that you’re more on top of this” (Participant 5, personal communication, August 6, 2020).

"I guess the way I've always looked at it as trying to be open and just willing to learn about where other people are coming from because I've learned you cannot assume at all..." (Participant 6, personal communication, August 10, 2020).

"I guess first to understand different cultures and that people function differently in different cultures, and with that understanding, then being able to communicate and interact in a way that is, first of all, respectful, and secondly, even embracing or from a desire to learn" (Participant 8, personal communication, August 12, 2020).

"And that does require me to be eager to learn about different cultures and just be aware that people may have different values and beliefs that are impacting their care and that it's important for me to also be aware of these things and to be actively learning and engaging as well...I think much of that is experience, but we probably also have to go out of our way to educate ourselves on different cultures, knowing that we might not have a lot of interaction to learn just through experience that way" (Participant 12, personal communication, August 20, 2020).

Several participants expressed that cultural competence is an ongoing process and that one cannot ever be completely culturally competent.

"It's more than obviously knowing you're never going to be an expert in everyone's culture. You're never ever going to be able to understand where everyone is" (Participant 3, personal communication, July 16, 2020).

"...I don't know that you really could be competent in all the cultures" (Participant 6, personal communication, August 10, 2020).

"I think me and people in general tend to think what they do is better so that's been an ongoing learning process, just about living and not just practicing medicine" (Participant 8, personal communication, August 12, 2020).

Participants shared that it involves individualizing care to each patient based on their needs, desires, background, values, practices, etc. which may require changing one's approach.

"And we have to take that into consideration with regard to how their cultural background would affect the conversation itself, decision making, advanced care planning, and even long term care plans for the patient, because that's important. Because different cultures have different ways of dealing with health care issues" (Participant 2, personal communication, July 15, 2020).

"It's being able to talk with a patient, let them know that I'm willing to hear what they need to do and share decision making. It involves being able to know where they're

coming from” (Participant 3, personal communication, July 16, 2020).

“To me cultural competence is the ability to provide good care, and also to be subjective across the lifespan, across gender, cultural, religious backgrounds, that meets that patient’s needs” (Participant 4, personal communication, July 22, 2020).

“Cultural competence is a type of intelligence that allows you to anticipate and to change your approach based on the culture of an individual and what their needs are” (Participant 10, personal communication, August 18, 2020).

### **Applying Cultural Competence**

In regards to the application of cultural competence, several similar phrases and words were discussed (Fig. 5). However, several unique phrases were expressed as well. Again, the responses are separated based on certain themes that manifested throughout the interviews, but some responses do overlap more than one theme. There also is some repetition in the phrases or words that were used to define cultural competence.

The word “ask” was mentioned in all interviews, referring to the practice of asking patients their preferences, expectations, desires, and concerns, as well as asking if there is a gap in cultural knowledge or understanding. Asking open ended questions can help facilitate communication and develop a deeper connection with patients.

“I think instead of assuming a specific culture, practice, or belief for my patients that I actually ask them. You know, if there were any cultural beliefs or religious beliefs that would impact their care or opinion on any medications or procedures, so I can understand where they’re coming from because it may not be something that I know of or share their belief in, so that I can understand what drives them.” (Participant 1, personal communication, July 14, 2020).

“I think just to ask is the biggest part. ‘What do you need?’ ‘What can I do to help you?’... (Participant 3, personal communication, July 16, 2020).

“A lot of the stuff that I picked up along the way has just come from asking questions of my patients like, “How do you want to be addressed? Is there anything that makes you uncomfortable? What can I do better?” (Participant 4, personal communication, July 22, 2020).

“I think because of my background working in the cities [Twin Cities] and being exposed to that, I do feel like I am a little bit more sensitive to it when someone is coming from a different background, but understanding that I can’t really understand them as myself. I think, again, just trying to be open minded and ask questions.” (Participant 6, personal communication, August 10, 2020).

"I make sure and ask permission. That's actually on the entry form is 'Are there any things related to childbirth and children that you would like us to honor?' So I guess just asking, because you can't assume." (Participant 9, personal communication, August 13, 2020).

"I think treating each patient individually and asking open ended questions if you don't understand what you're hearing. I think that also admitting to not only yourself, but the patient, if you feel like you are missing something that is important to them and their care and you think that might be due to a gap in knowledge or a misunderstanding based on their culture." (Participant 11, personal communication, August 19, 2020).

"I do try to ask really open ended questions and really try to learn from patients and also just create that space for them to communicate certain things about their culture that I should be aware of." (Participant 12, personal communication, August 20, 2020).

Several participants also mentioned accepting patients as they are and respecting them as being central to applying cultural competence.

"Just having the respect of being able to use the right pronouns and call them by their preferred name and be able to ask them what they need." (Participant 3, personal communication, July 16, 2020).

"I think getting the word out and being supportive.." (Participant 4, personal communication, July 22, 2020).

"You have to treat everybody well and you have to do your best to give everyone the right care.." (Participant 10, personal communication, August 18, 2020).

A focus on social determinants of health, such as social and economic factors, was mentioned as important to fully understand patients and where they are coming from.

"There are people who have a very good support system. That they do manage better, even if they have challenges." (Participant 2, personal communication, July 15, 2020).

"Cause sometimes there's something else that we need to help them with to improve the bigger picture," (Participant 2, personal communication, July 15, 2020).

"I think the time the cultural stuff does come up is with social determinants of health." (Participant 6, personal communication, August 10, 2020).

"We definitely were required to do some community projects and definitely looking into areas of health disparities where you start just becoming aware of how certain things like race and ethnicity, or income brackets, and all of these things, how that affects people's health as well." (Participant 12, personal communication, August 20, 2020).

Similar to the definition of cultural competence, having care be individualized to the patient was expressed as a way to apply cultural competence.

“Everybody is not the same so I think that forming a cookie-cutter approach doesn’t work and that you have to understand where they’re coming from, so we can tailor our response or our treatment or the way we approach something to them.” (Participant 1, personal communication, July 14, 2020).

“...but the right care for one individual may be different from another individual based on their cultural perceptions and their history. Like I said, it’s not something that happens in isolation.” (Participant 10, personal communication, August 18, 2020).

Many participants shared that staff collaboration was utilized to ensure that all patients were receiving quality, culturally competent care. This collaboration is often effective because staff diversity within the department can provide helpful knowledge and varied perspectives.

“When we were there, we had faculty and staff and nurses who actually are from the same background so that’s how we learned. They would give you feedback of how it is, or maybe how to approach.” (Participant 2, personal communication, July 15, 2020)

“Honestly, our department’s pretty diverse compared to most departments... I feel like it’s at the forefront and we do have more of those conversations.” (Participant 3, personal communication, July 16, 2020).

“I think a lot of times we just look to each other too. We talk about cases, if there’s been any misunderstandings or things that could have gone better. We’ll talk as a group and do a peer review.” (Participant 4, personal communication, July 22, 2020).

“There was a lot of diversity at the clinic but affluent diversity. So other residents and learners that came from different backgrounds, but not economic issues for them.” (Participant 6, personal communication, August 10, 2020).

“I think there are ways to do it, like having your coworkers tell you what their experience and their knowledge is.” (Participant 8, personal communication, August 12, 2020).

“I think when we give report if there’s a cultural issue, we make sure that the next person coming on knows.” (Participant 9, personal communication, August 13, 2020).

“I also know that this is a really safe place to work as far as calling up someone and picking up the phone and saying, ‘I had this interaction with this type of patient and it didn’t work, and I’m not sure why, but I know that you have experience. Can you help me understand? That is expected here.’” (Participant 11, personal communication, August 19, 2020).

Less common phrases that were used included: “active”, “don’t assume”, “self awareness of biases”, “ongoing process”, “desire to learn and understand”, and “eliminating power dynamics”. Participants explained that being self-aware of one’s own biases and eliminating power dynamics are both essential in this process. Both of these aspects allow each provider to understand where they are in relation to patients and also helps to develop a better provider-patient relationship.

“I think we can always improve on the way we communicate to patients. Like I was saying before, I’m going to think cultural competency is this ongoing process and not something of like, Yes, I studied it. I did the trainings and I arrived. I think that it does require ongoing focus and especially in people who are not actively working with people from different cultures on a regular basis.” (Participant 12, personal communication, August 20, 2020).

“Cultural competence isn’t necessarily a one way street either because you have to be aware of your own biases going in.” (Participant 10, personal communication, August 18, 2020).

“...and not having a hierarchical way of dealing with patients...You have to be at their level...Having them know that they are in charge of their health care is a prime reason to even become a midwife...Nothing in my job description makes me higher than them.” (Participant 3, personal communication, July 16, 2020).

## **Cultural Competence Training**

### **Prior to Employment**

Participants were asked about the cultural competence training they had received prior to employment (Fig. 6). All 12 participants expressed that they had this training embedded in their medical school or nursing school classes. Information provided in these classes usually included the following: brief knowledge of cultural customs and practices, different religious beliefs in relation to health care, tips on how to be inquisitive, empathetic, and sensitive, the role of a provider, the soft skills of interacting with others, and how to handle difficult patients. Many participants indicated that this information was simply incorporated into classes, but there was never a formal training on diversity or cultural competence. Therefore, several participants expressed that they were not impressed with this training while in school and believed other training methods were more helpful and effective. Participants commonly expressed that they received cultural competence training from their personal experiences, citing their childhood and personal travel as sources of this training. Growing up in diverse communities helped these individuals become more comfortable with cultures different from their own by gaining exposure early on in their lives. Additionally, personal travel to other states and countries helped these individuals gain experience with different religions, attitudes, and cultural knowledge, such as dress and gestures. They also expressed that it changed

their worldview and helped them “take their blinders off” and engage with other people. In addition to personal travel, many participants did study abroad in countries including South Africa, India, and Mexico during their undergraduate careers, which again allowed them to gain more exposure to other cultures, step out of their comfort zone, and get a new perspective. Finally, while in medical school or nursing school, several participants went on home-visits, which involved traveling to the patient’s home to provide care. Home visits gave providers helpful insight into a patient’s lifestyle, values, and beliefs, resulting in a more holistic view of their patients.

### **On the Job Training**

Participants were also asked about training they received while on the job (Fig. 7). Many mentioned the Computer Based Trainings (CBTs) that are required quarterly by their facility. These online modules do cover cultural competence, but 6 of the 9 individuals who mentioned CBTs expressed that they were ineffective and very brief. The other 3 individuals mentioned that these modules were helpful to serve as a reminder, but still preferred alternative methods. A few participants mentioned the onboarding process, or employee orientation, as a source of on-the-job training. These individuals shared that the cultural competence information presented in this employee orientation was also brief and ineffective. Alternative methods of training that were described included seminars, classes, and grand rounds, which involve discussions and dialogue between providers. These often involve presentations from health experts, public health officials, or guest speakers who can speak about the cultural needs in the area. All 7 of the participants that mentioned these alternative methods described them as effective in providing a better understanding of these topics and prepared them to provide culturally competent care. Overall, participants expressed that training involving dialogue and discussion was preferred and more effective. Conversational training methods allow providers to keep communication open and provide the opportunity to share ideas and experiences as well as get questions answered. They also help expose participants to ideas they might not normally consider. Hearing patient accounts and going through case studies and examples was also expressed to be helpful. Finally, previous work experience with diverse individuals was noted to be effective in providing cultural competence training. Past experiences exposed individuals to diverse populations, and therefore, increased their confidence and comfort with those populations.

### **Cultural Competence Resources**

Participants were questioned about what resources were available to them and which ones they used to provide culturally competent care (Fig. 8). Eleven of the participants mentioned that they had access to language services. These include in-person interpreters, interpreters accessed via phone or video, and patient education handouts in various languages. Some of the individuals who mentioned language services also expressed that although all of these options are readily available, they preferred in-person interpreters. In-person interpreters can provide a more personalized experience and often provide cultural awareness and knowledge as well. Several participants mentioned

### Definition of Cultural Competence

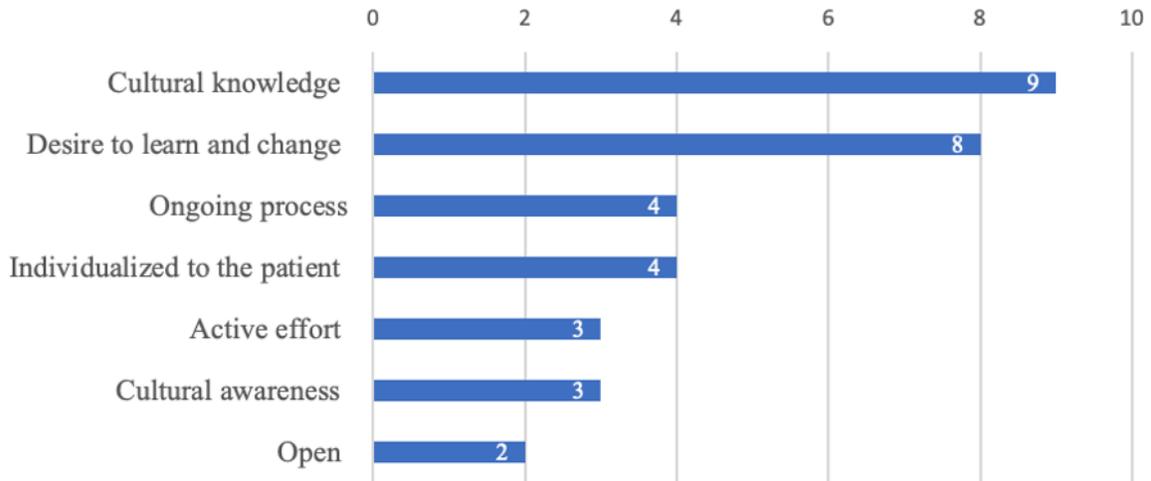


Figure 4: Participant responses regarding the definition of cultural competence.

### Application of Cultural Competence

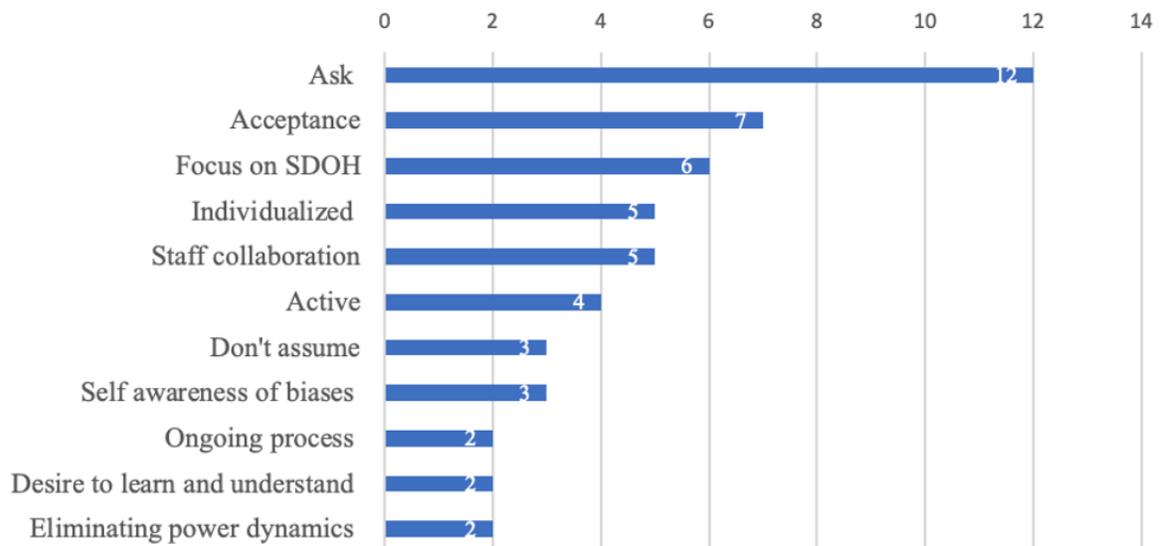


Figure 5: Participant responses regarding the application of cultural competence.

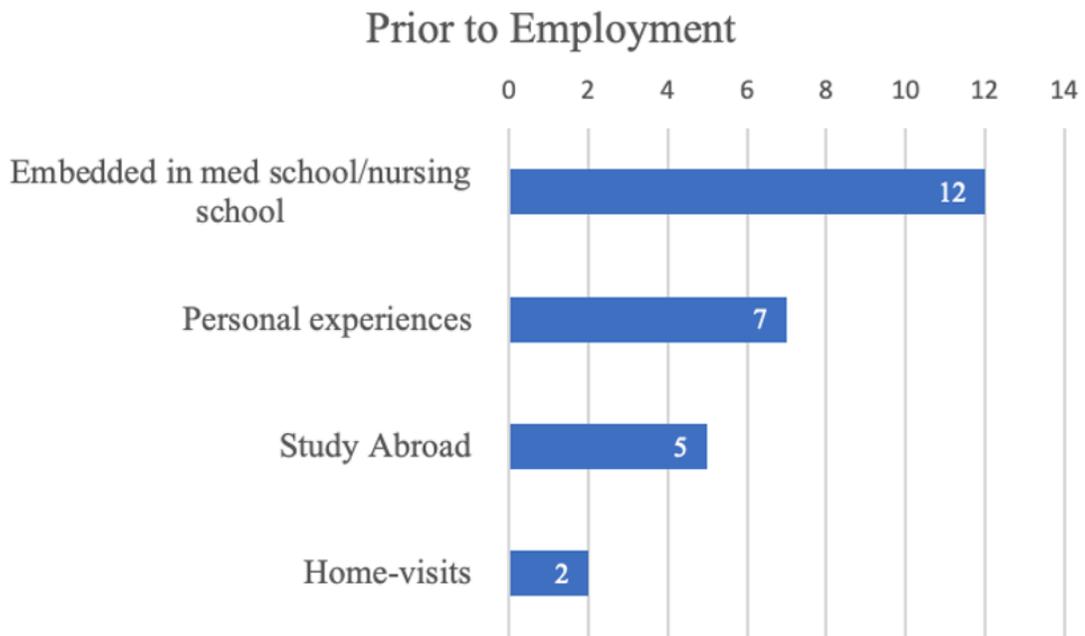


Figure 6: Participant responses regarding training received prior to employment

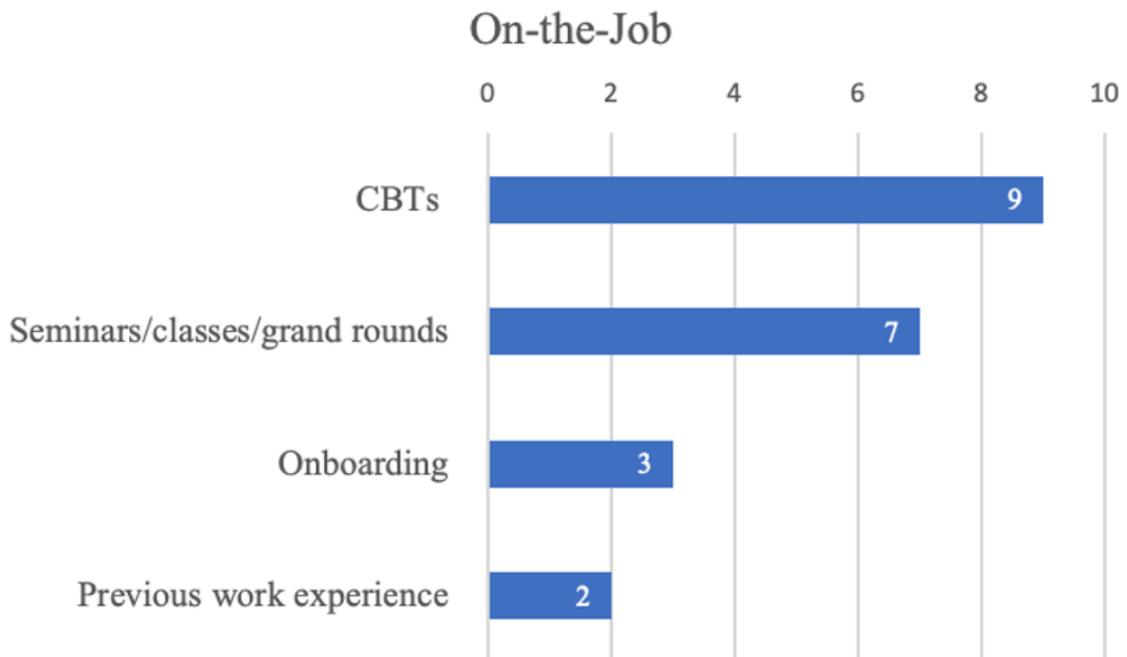


Figure 7: Participant responses regarding on-the-job training they have received.

the Diversity and Inclusion group that this facility has as a cultural competence resource. This group is made up of a variety of staff members and is involved in community outreach, community collaboration, and organizes staff education opportunities. One of these opportunities is the critical conversation dialogue series, which has been very successful. These are workshops that cover different topics related to equity, diversity, and inclusion and involve both lecture and discussion components. Participants noted that another way to access cultural competence information is to sign up for additional classes, CBTs, and seminars. Several mentioned seeking out information in scientific journals and articles, the in-house library, and online resources. One individual specifically mentioned the national guidelines and the facility's own guidelines that help to ensure consistent care.

**Discussion**

As expected, all participants defined and applied cultural competence in different ways. There were many commonalities between their definitions and the ways in which they applied cultural competence, but there also were differences. These differences are likely due to the fact that each participant has their own background, beliefs, values, and experiences. All of those differences will shape their understanding and application of cultural competence.

**Adherence to Theories**

Further analysis revealed certain theories of cultural competence were expressed in the participants' answers. To begin with, many of the participants included cultural awareness and cultural knowledge in their definitions, similar to the definition provided



Figure 8: Participant responses regarding cultural competence resources available to them.

by Betancourt et. al (2002). Betancourt's categories of culturally competent methods (organizational, structural, and clinical) were also expressed. Organizational methods present at this facility include the diversity within each department and the training sessions provided by the organization. Structural methods include considering one's own biases and eliminating power dynamics that may serve as barriers for culturally competent care. Clinical methods include communication and tailoring care based on individual needs. The idea that cultural competence involves appreciating and valuing holistic perspectives and is an ongoing, multistep process, as expressed by Spector (2017), was also shared by participants. Leininger's Culture Care Theory was echoed by several participants who noted the importance of considering the interrelationships between care and culture, and what effects that consideration can have on the quality of care provided. The various pieces of the provider level (cultural diversity, cultural awareness, cultural sensitivity, and cultural competence) shown in the 3D Puzzle Model, were all represented in participants' responses in some way. Participants stressed the importance of individualized care, which was expressed by the theory of Culturally Congruent Care. This is due to the fact that even within certain cultural groups, there is variability in beliefs, values, and practices. Additionally, the idea that these constructs are all interconnected and exist nonlinearly was shared between this theory and participants' responses. Finally, the importance of self awareness and identifying one's own biases, expressed by Kersey-Matusiak (2013), was mentioned by a few participants.

### **Areas for Potential Improvement**

Through analysis, several areas for potential improvement were identified. These include the CBTs and onboarding process, evaluations of current culturally competent methods, transgender education, access to in-person interpreters, and patient evaluations.

Many participants expressed that the CBTs and employee orientation provided minimal information. They also shared that they were not effective in providing helpful education of cultural competence. These participants preferred more group discussions that included dialogue and/or guest speakers from the community. Trainings like these could be implemented in conjunction with the existing methods or in place of them. Additionally, all participants were unaware of any assessments or evaluations of the current culturally competent methods being used. This would be an area of further investigation, and if necessary, it could be discussed how these evaluations would be completed. Four participants expressed that transgender education was lacking. They felt they lacked the resources to support transgender individuals effectively, making this a potential topic to focus on in training and provide more resources on. In relation to the language services, three participants preferred in-person interpreters. If possible, more in-person interpreters could be made available on site for patients. Finally, it was suggested by two of the participants that more patient evaluations be sent out, specifically regarding the cultural competence of providers. This would help to reveal any deficiencies in the care that is being provided and would lead to further growth and improvement. Correcting any issues that exist could lead to the reduction of health care disparities.

### **Conclusion**

Although this study only focused on one health care facility and had a limited number of participants, a great deal of helpful information was still revealed. These findings will be shared with the facility the participants work at. Suggestions for possible improvements, which were formulated by critically assessing interview responses, will also be shared. If possible, these suggestions will be utilized to develop plans to improve staff's ability to provide culturally competent care. Finally, there is also the potential to extend this study or to suggest a similar study to other facilities in the area. Doing so would allow for a greater understanding of cultural competence in health care. It also could lead to improvements in the methods currently used with the end goal of decreasing health care disparities.

## Appendix A

### National Standards for Culturally and Linguistically Appropriate Services (CLAS) in Health and Health Care

#### **Principal Standard:**

1. Provide effective, equitable, understandable, and respectful quality care and services that are responsive to diverse cultural health beliefs and practices, preferred languages, health literacy, and other communication needs.

#### **Governance, Leadership, and Workforce:**

2. Advance and sustain organizational governance and leadership that promotes CLAS and health equity through policy, practices, and allocated resources.

3. Recruit, promote, and support a culturally and linguistically diverse governance, leadership, and workforce that are responsive to the population in the service area.

4. Educate and train governance, leadership, and workforce in culturally and linguistically appropriate policies and practices on an ongoing basis.

#### **Communication and Language Assistance:**

5. Offer language assistance to individuals who have limited English proficiency and/or other communication needs, at no cost to them, to facilitate timely access to all health care and services.

6. Inform all individuals of the availability of language assistance services clearly and in their preferred language, verbally and in writing.

7. Ensure the competence of individuals providing language assistance, recognizing that the use of untrained individuals and/or minors as interpreters should be avoided.

8. Provide easy-to-understand print and multimedia materials and signage in the languages commonly used by the populations in the service area.

#### **Engagement, Continuous Improvement, and Accountability:**

9. Establish culturally and linguistically appropriate goals, policies, and management accountability, and infuse them throughout the organization's planning and operations.

10. Conduct ongoing assessments of the organization's CLAS-related activities and integrate CLAS-related measures into measurement and continuous quality improvement activities.
11. Collect and maintain accurate and reliable demographic data to monitor and evaluate the impact of CLAS on health equity and outcomes and to inform service delivery.
12. Conduct regular assessments of community health assets and needs and use the results to plan and implement services that respond to the cultural and linguistic diversity of populations in the service area.
13. Partner with the community to design, implement, and evaluate policies, practices, and services to ensure cultural and linguistic appropriateness.
14. Create conflict and grievance resolution processes that are culturally and linguistically appropriate to identify, prevent, and resolve conflicts or complaints.
15. Communicate the organization's progress in implementing and sustaining CLAS to all stakeholders, constituents, and the general public.

## **Appendix B**

### **Semi-Structured Interview Questions**

#### **Introduction**

Could you tell me a little about yourself?

How did you decide to pursue a career in health care?

How long have you been working at this facility?

What is your position and what are some of your responsibilities in that role?

How do you identify? What is your race? What is your ethnicity? What is your sex?

What are your pronouns? (e.g., she/her/hers, him/his/he, they/them/their)

#### **Cultural Competence Understanding and Application**

What is cultural competence? How would you define it?

How do you apply cultural competence in the workplace?

What does cultural competence look like in your current unit/department?

What cultural competency training did you receive both prior to your employment and since you have been employed?

How effective was that in preparing you to provide culturally competent care?

How do staff develop and maintain their cultural competency? What methods (materials, training programs, guidelines, etc.) are currently being used at this location to improve cultural competence among staff members?

Have these methods and services been assessed in the past? If so, please provide examples and/or results that you may be aware of.

#### **Closing**

Would you like to be contacted to review the transcription of the interview?

Would you like to receive a copy of the final paper discussing the findings?

Are there any other questions that you have for me regarding this research?

**Appendix C**

Table 1: Participant Demographics

			Time at	Race	Ethnicity	Sex	Pronouns
1	P	FM	3 yrs	Asian	Indian	F	She/her/hers
2	P	FM	-*	Asian	Filipino	F	She/her/hers
3	NM	OBGYN	-*	White	Irish/Swedish/Scottish, Non-Hispanic	F	She/her/hers
4	NP	OBGYN	-*	White	Western European	F	She/her/hers
5	N	FM	-*	White	American	F	She/her/hers
6	NP	FM	7 yrs	White	American (Belgian, German, French)	F	She/her/hers
7	N	OBGYN	4.5 yrs	White	Non-Hispanic	F	She/her/hers
8	P	OBGYN	3 yrs	White	Northern European	F	She/her/hers
9	NP	OBGYN	4 yrs	White	Non-Hispanic	F	She/her/hers
10	N	OBGYN	1 yr	White	Non-Hispanic	F	She/her/hers
11	P	FM	-*	White	German	M	He/him/his
12	NM	OBGYN	9 yrs	White	Non-Hispanic	F	She/her/hers

\*- indicates that time at facility was not mentioned in the interview

Table 2: Key for Table 1

Position	Department	Sex
P=Physician	FM=Family Medicine	F=Female
NP=Nurse Practitioner	OBGYN=Obstetrics and Gynecology	M=Male
NM=Nurse Midwife		
N=Nurse		

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## Hindsight Bias in Judgements of Dating Couples

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### Abstract

Hindsight bias, also known as the “I knew it all along” effect, exaggerates our ability to understand our initial perceptions and predictions after something has already occurred. Although hindsight bias is a universal cognitive phenomenon, there are cultural differences in how it is exhibited. Hindsight bias has been studied in various contexts, such as clinical diagnoses, rape, and eyewitness testimonies, but has yet to be assessed in a romantic context. When considering romantic situations, individual differences, such as gender and sex, can influence how the relationship is perceived. Considering these individual differences, hindsight bias in relationships should be assessed from an outside perspective to minimize the effect of potential distortions.

### Introduction

Hindsight bias is a phenomenon that is often discussed in the field of psychology. Hindsight bias, also known as the “I knew it all along” effect, tends to exaggerate our ability to understand our initial perceptions and predictions after something has already occurred. This phenomenon occurs in our everyday lives in various contexts, ranging from clinical diagnoses to relationship dissolutions. For instance, upon dissolution of a romantic relationship, we are able to identify red flags and we then blame ourselves for not seeing these signs earlier because they seem so obvious now that the relationship is over. As obvious as these signs may seem after the relationship is over, in reality it is actually quite difficult for us to predict how the relationship will turn out. We encounter innumerable ambiguous signals as we move through our lives, but once something happens, we are able to sort out these signals and find ourselves believing that we knew it all along or that we saw it coming. This study will incorporate and build off of previously conducted research regarding hindsight bias and will further explain this phenomenon through an assessment of hindsight bias in the context of romantic relationships.

## **Literature Review**

To understand hindsight bias, it is essential to discuss the difference between hindsight and foresight. The difference between the two is whether we have outcome knowledge. When reflecting on the past, hindsightful judges have outcome knowledge because the events have already occurred and they are aware of how a situation turned out (Fischhoff, 1975). When we are looking towards the future, being a foresightful judge, we do not have outcome knowledge.

Hindsight bias tends to be centered around the perceived predictability and inevitability of an event occurring. According to Roese and Vohs, hindsight bias is the belief that an event is more predictable after its outcome becomes known (2012). The phenomenon also involves the inability to recreate the feeling of uncertainty that came before receiving outcome knowledge. In other words, it is difficult to imagine foresightful perceptions once we are given outcome knowledge (Roese & Vohs, 2012).

## **Theories to Consider**

Baruch Fischhoff describes the concept of creeping determinism, the hypothesized tendency to perceive reported outcomes as having been relatively inevitable (1975). Similarly, philosophical determinism is the conscious belief that the outcome, regardless of what it may be, has to happen. These two hypotheses highlight the aspect of perceived inevitability involved in hindsight bias.

Upon dissecting the phenomenon of hindsight bias, researchers have found that there are three different kinds of hindsight bias (Roese & Vohs, 2012). One kind of hindsight bias is having a faulty recollection of an earlier judgement, also known as memory distortion. Those practicing this kind of hindsight bias tend to say, "I said it would happen," after the event has already occurred. Another kind of hindsight bias is inevitability, which we have previously discussed. Inevitability is a combination of memory distortion and a belief in causal forces. It revolves around the belief that the state of events was predetermined, leading people to say things along the lines of, "it had to happen." Lastly, the third kind of hindsight bias is foreseeability, which is a combination of inevitability and an individual's own understanding of the world, which would sound like, "I knew it would happen" (Roese & Vohs, 2012).

## **Inputs that Influence Hindsight Bias**

Roese and Vohs also detail the different mental inputs that can influence hindsight bias (2012). A cognitive input affects the operations of memory, which includes recollection, knowledge updating, and sensemaking. Recollection is how the memory is retrieved. In hindsight bias, we are practicing recollection by trying to estimate our initial predictions (Roese & Vohs, 2012). Knowledge updating is a process where new information is taken and integrated into existing memory. If the newfound knowledge pertains to the old information, then the past is better understood because of the new information. Sensemaking is when we develop causal explanations to form a sense of meaning,

which enhances perceived inevitability (Roese & Vohs, 2012). Sensemaking stems from our innate tendency to locate a cause and effect in any given situation. Situations that have causal explanations have a greater hindsight bias than situations that are more ambiguous. Therefore, when there is a surprising outcome, there is a heightened probability for a greater degree of hindsight bias when the outcome can be connected to coherent, clear, and plausible explanations (Roese & Vohs, 2012). Although it is reasonable for us to make these connections, our need for cause-and-effect leads us to develop hypothetical counterfactuals. Developing hypothetical counterfactuals means we develop the idea that the outcome could have occurred differently despite its reality (Roese & Olson, 1995). Counterfactuals typically involve an “if” (a personal action) and a “then” (a personal goal) to represent alternatives to the factual events (Roese et al., 2006). To put this in a relationship context, let’s say that Sofia and Daniel are in a long distance, romantic relationship. After six months of dating, we are told the two have broken up. Given this information, it would be natural to say that the distance apart caused the breakup, but this is not for certain. It would also be natural for Sofia and Daniel to develop hypothetical counterfactuals. If the two lived closer together, then would they have stayed together longer? On the other hand, if they did live closer together, then would they have broken up earlier since they got to see each other more often and became familiar with one another’s faults sooner? Despite these hypotheticals, it does not change the reality of the breakup. The hypothetical counterfactual is only a method to understand the cause behind it.

There is also a metacognitive input involved in hindsight bias. Metacognition is the ability to understand one’s own thoughts. A common metacognition in our everyday lives involves questioning ourselves and self-reflection (Roese & Vohs, 2012). Metacognitive inputs are subjective judgements, and they tend to have the greatest effect on the foreseeability aspect of hindsight bias, because it is also subjective. As stated previously, other studies support the idea that when people find a plausible, logical connection behind the reason for an outcome, they will show a greater sense of hindsight bias (Roese & Vohs, 2012). The sense of ease provided by satisfying our innate desire for causality/cause and effect leads to an idea of certainty. This certainty, in turn, enhances our idea that we knew all along that the outcome would occur. In the context of our hypothetical relationship, Sofia and Daniel, it would be easy to conclude that the reason behind the breakup was the distance, but in reality there are countless other factors that could have played a part in their dissolution.

Motivation is another factor in the development of hindsight bias. Like metacognitive inputs, motivation affects foreseeability as motives are centered around the wants and needs of the individual (Roese & Vohs, 2012). The motivational input is influenced by self-esteem, as people want to view themselves in a positive light. When trying to explain the past, people oftentimes take credit for success and blame others for their failure (Roese & Vohs, 2012). Motivational input also involves the need for closure. According to Roese and Vohs, people have a need to see the world as predictable because we feel

threatened by uncertainty. Those that have a greater need for control or closure often exhibit greater hindsight bias. The need for control and closure is one factor that can lead individuals to try and find patterns in randomness, painting a false sense of reality.

### **Hindsight Bias in Previous Contexts**

The study of hindsight bias in previous contexts can contribute to and amplify the phenomenon. It has been studied and demonstrated in a variety of settings, including clinical diagnoses (Arkes, Wortmann, Saville, & Harkness, 1981), eyewitness testimonies (Neisser, 1981), rape (Carli, 1999; Janoff-Bulman, Timko, & Carli, 1985), employee evaluations (Mitchell & Kalb, 1981), and suicide (Goggin & Range, 1985).

Findings of various studies. Baruch Fischhoff was the first to document hindsight bias in 1975. Fischhoff's study was the foundation for future works on hindsight bias. This study found that receiving outcome knowledge significantly increased the perceived likelihood of the event occurring. In fact, it nearly doubled the perceived likelihood. Further, Fischhoff found that we are typically unable to reconstruct the perceptions we had before we received outcome knowledge. In other words, after an event occurs, it is difficult to reconstruct foresightful judgements. Although hindsight bias is a basic cognitive process, there is potential for individual differences to affect the magnitude of hindsight bias. Oftentimes in research, study samples do not include those outside of Westernized society. Therefore, it is necessary to examine the potential existence of cultural differences in hindsight bias.

Considering culture in hindsight bias. Researchers have previously assumed that hindsight bias is reflective of basic features of the human information-processing system, so it should have adaptively evolved to meet the needs of everyone. Therefore, hindsight bias should be the same in every culture (Pohl et al., 2002). When comparing East Asian cultures and Western cultures, those in East Asian cultures exhibited more hindsight bias while those in Western cultures were either more surprised by the unexpected outcome or showed no evidence of hindsight bias. By addressing cultural differences and how it may have an influence on the degree of hindsight bias, it enhances the credibility of the research findings. Given that cultural differences affect hindsight bias, it is arguable that there is also potential for gender differences to influence hindsight bias as well.

### **Hindsight Bias and Romantic Relationships**

As most people will experience the dissolution of a romantic relationship, it is important for us to assess how hindsight bias may influence our experiences of romantic relationships and how we perceive the relationship after its dissolution because in the weeks following a breakup, people tend to report an increase in negative emotions and a decrease in life satisfaction (Rhoades, Dush, Atkins, Stanley, & Markman, 2011).

Relationship perceptions after the breakup. Although everyone has their own individual experiences during a breakup, there are significant findings that show similarities, by gender, on perceptions of relationships after they have ended. Contrary to popular belief, breakups seem to be more traumatic for men than for women (Hill et al., 1976). Men

report feeling more depressed, lonely, less happy, and less free. Men also find it harder to cope with no longer being loved and the relationship being over (Hill et al., 1976). It is arguable that because there are gender differences in the perception of relationship experiences, these differences could influence the magnitude of hindsight bias in a romantic relationship.

Assessing hindsight bias in the context of a romantic relationship. To date, there have been minimal studies on how hindsight bias influences perceptions of romantic relationships after dissolution. Previously conducted studies typically involve participants self-reporting their own relationship experiences, which leaves room for distortion. There are three reported influences that could affect the accuracy of reports of romantic partners (Halford et al., 2002). The first influence is the characteristics of the environment individuals are being asked in. For instance, individuals will talk about the relationship differently if their partner is present versus if they are alone with their friends. Another influence is individual biases when discussing specific events in the relationship. For instance, an egocentric bias could lead individuals to overreport their own positive behaviors and underreport their negative ones. Another way individual biases create distortion is that satisfied couples perceive their partner's behaviors more positively in comparison to those in distressing relationships (Halford et al., 2002). The third influence is having memory bias in the recall of relationship events. This means negative events are more salient for those that are not satisfied in relationships, thus making it easier to look at a relationship negatively (Halford et al., 2002).

### **Hindsight Bias in a Romantic Relationship from an Outside Perspective**

Past studies have shown there is a lot of room for inaccuracy when self-reporting. There are gender differences in relationships as women and men have different reasonings behind wanting to end a relationship, as well as having different emotional reactions afterwards. Furthermore, when reporting their own relationships, there are multiple biases at play. Considering the distortions present when individuals discuss their own relationship experiences, it is essential to assess hindsight bias from a subjective, third-party perspective, which leads to my current study.

In this study, we tested the proposal that hindsight bias occurs in the context of romantic relationship judgements. We aimed to manipulate people's perceptions of a romantic couple, Sofia and Daniel, by providing different forms of outcome knowledge. The groups that were given outcome knowledge have the potential to be influenced by hindsight bias while the group not given any information operate as the control group and as a foresightful judge.

## Methodology

### Participants

**College Sample** For this study, we collected a college sample and a community sample. For the college sample, we used Qualtrics and University of Wisconsin-Eau Claire's SONA research participation system to distribute our survey to 262 University of Wisconsin-Eau Claire students, ranging in age from 18 to 27 ( $M = 19.4$ ,  $SD = 1.38$ ). Each participant was randomly assigned one of three outcome knowledges functioning as experimental groups.

**Community Sample** For the community sample, we utilized Amazon's Mechanical Turk to collect responses from 331 people across the United States, ranging from 24 to 76 ( $M = 41.6$ ,  $SD = 11.20$ ). Each participant was paid \$1.00 for their participation. Participants were randomly assigned one of three outcome knowledges functioning as experimental groups.

**Demographics** All participants reported their age, biological sex, race/ethnicity, sexual orientation, and current romantic involvement. For the community sample, participants were asked about their romantic history, specifically how many committed relationships they have been in and how many breakups they have experienced. We only asked the community sample these questions with the rationale that they have had more experience dating due to age.

### Materials

**Relationship Vignette** All participants received a survey that introduced a romantic couple, Daniel and Sofia, and some background on their romantic relationship. A hypothetical vignette introduces the participants to the couple and goes on to describe the positives of their relationship and some issues they have as well (Appendix A). After reading this information, one group of participants are told that six months later the couple had broken up, which we will refer to as the "broken up group," and another group is told that the couple have gotten engaged, referred to as the "engaged group." A third group did not receive any outcome knowledge, operating as a control group because without outcome knowledge they do not have the ability to be influenced by hindsight bias. The sample size and distribution for each outcome knowledge group are provided in tables 1 and 2.

**Relationship Judgements** Participants then answered a series of questions to provide judgements about the quality of the couple's relationship and their perceptions of the couple's future. We asked participants to guess the status of Sofia and Daniel's relationship six months later, which we refer to as the six-month forecast. We also asked participants to rate how obvious it seemed for the couple to either break up or be engaged

six months later, which we termed as the “obviousness” of an outcome, on a seven-point scale (Surprising to Neither surprising nor obvious to Obvious).

### **Procedure**

Researchers followed standard consent procedures. The study was distributed electronically using SONA, Qualtrics, and Amazon’s Mechanical Turk. Consent information was provided on the cover letter, noting that continuing onto the questionnaire would imply the students’ consent to participate. When all participants had finished, the participants were virtually debriefed, outlining the background behind the research, the 3 possible scenarios that participants could be assigned to, and our predictions.

### **Results and Discussion**

Overall, we found that being given knowledge of a breakup influenced perceptions of a relationship’s trajectory. The college sample and the community sample had multiple differences in their responses to a six-month forecast. We also assessed the perceived obviousness of the two either breaking up or getting engaged as a way of estimating perceived inevitability. The college and community sample significantly differed on the perceived obviousness of breaking up and the perceived obviousness of the two getting engaged.

**College Sample** For the six-month forecast, participants were asked to state where they believed the couple would be in six months on a scale of “they will have broken up” to “they will have gotten engaged.” Within the college sample, we found that those who were told the couple had gotten engaged significantly differed from those who were told they had broken up, but not from those in the control group (Figure 1). For the obviousness of breaking up, we found that college students did not significantly differ, regardless of the outcome they were given (Figure 2). For the obviousness of the two getting engaged, we found that college students who were told they had gotten engaged rated it more obvious that the two would be engaged six months later in comparison to those who were told they broke up. However, there was not a significant difference between the control group and the other two outcomes (Figure 3).

**Community Sample** For the six-month forecast, each experimental group was significantly different from one another; those who were told the couple got engaged had forecasted engagement more than those who were not told anything and even more than those who were told Sofia and Daniel had broken up (Figure 1). For the obviousness of breaking up, the community sample was significantly different across the board (Figure 2). Specifically, those who were told they had broken up thought it was more obvious in comparison to the control and the engaged group. In this scenario, the control group and the engaged group significantly differed as those in the engaged group thought it was the least obvious for the two to break up. For the obviousness of the two getting engaged, there was a significant difference between each group, which highlights the effects of hindsight bias. The group that was told they were broken up found it more

surprising while those told they had gotten engaged found it more obvious (Figure 3).

### **Conclusion**

In this study, we have found that in most cases, hindsight bias can have an effect on our perceptions of a romantic relationship. Our findings show that when predicting a couple's future, receiving outcome knowledge significantly impacts our perception of a couple's relationship trajectory. However, when examining different aspects of hindsight bias, we found an interesting trend between the college and community sample. For the college sample, although there was a significant difference found between the broken-up group and the engaged group, there oftentimes would not be a significant difference between the control group and the engaged group. On the other hand, there was a significant difference between each group for the community sample. Although we cannot say for certain, we speculate that this could be explained by the age of the participants as the community sample is much older and therefore we assume the community sample has more relationship experience to reference in comparison to the college sample, leading to significantly different responses.

Although my current study's findings have the potential to be rudimentary in assessing hindsight bias in the context of a romantic relationship, there are limitations that must be acknowledged. For instance, despite the fact that my study sample has participants across the United States, this is not representative as it does not fulfill a cultural lens. Further, my study does not account for individual differences but rather assesses hindsight bias in a broader context. Therefore, for future research, we encourage further exploration by incorporating a multicultural aspect beyond the United States. We also suggest assessing potential psychological consequences of hindsight bias in romantic relationships. Overall, this research shows that when a relationship ends, there is no way for us to predict if we really saw it coming. The data we collected suggests that the outcome of a relationship, specifically a relationship dissolution, may not be as obvious or as predictable as it seems. Our innate reaction, that we should have seen it coming, can be explained by the phenomenon of hindsight bias.

**Table 1**

Participants' Evaluations of Daniel and Sofia's Relationship as a Function of Outcome Knowledge Condition (College Student Sample)

	Broken Up M [95% CI]	Control M [95% CI]	Engaged M [95% CI]
Six-month forecast of their relationship status	4.79 [4.31, 5.27]a	5.96 [5.56, 6.36]b	6.19 [5.65, 6.73]b
Perceived obviousness of Sofia and Daniel breaking up in the future	4.52 [4.24, 4.80]a	4.23 [3.99, 4.47]a	4.37 [4.11, 4.63]a
Perceived obviousness of Sofia and Daniel getting engaged in the future	3.15 [2.89, 3.41]a	3.52 [3.26, 3.78]ab	3.87 [3.59, 4.15]b
Negative evaluation of the relationship ( $\alpha=.77$ )	3.81 [3.55, 4.07]a	3.33 [3.07, 3.59]b	3.24 [2.98, 3.50]b
Positive evaluation of the relationship ( $\alpha=.72$ )	3.87 [3.61, 4.13]a	4.50 [4.26, 4.74]b	4.63 [4.39, 4.87]b

Note. The six-month forecast was on an 11-point scale ranging from “they will have broken up” (scored as 1) to “they will have gotten engaged (scored as 11). All other items were rated on seven-point scales (surprising to obvious, strongly disagree to strongly agree). Broken-up (N=85), Control (N=91), Engaged (N=86).

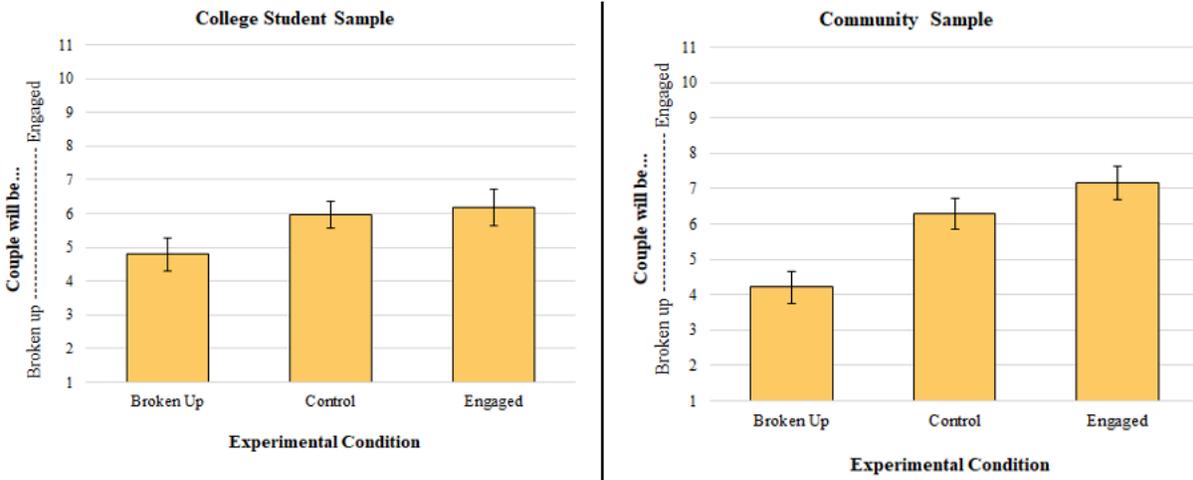
**Table 2**

Participants' Evaluations of Daniel and Sofia's Relationship as a Function of Outcome Knowledge Condition (Community Sample)

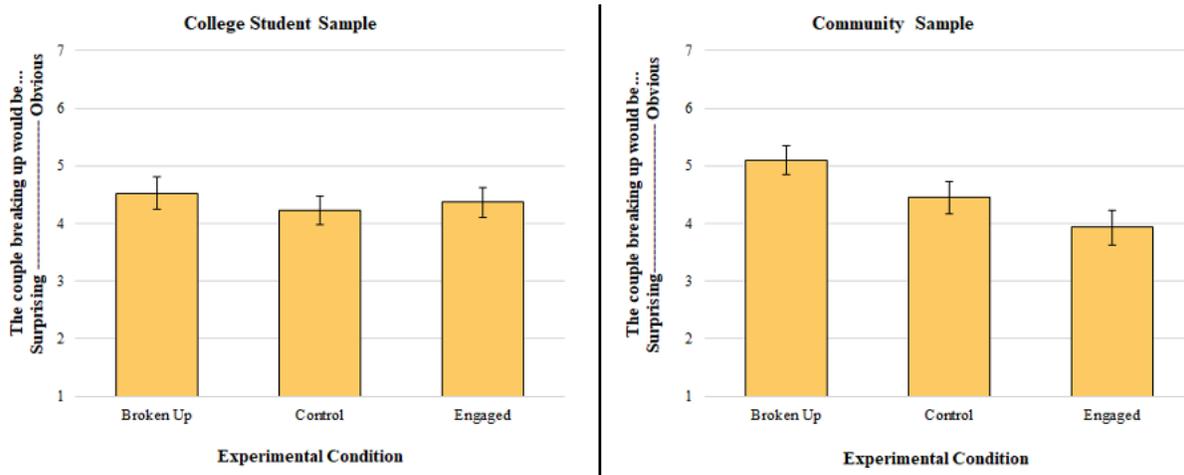
	Broken Up M [95% CI]	Control M [95% CI]	Engaged M [95% CI]
Six-month forecast of their relationship status	4.21 [3.77, 4.65]a	6.29 [5.87, 6.71]b	7.17 [6.70, 7.64]c
Perceived obviousness of Sofia and Daniel breaking up in the future	5.10 [4.86, 5.34]a	4.45 [4.17, 4.73]b	3.93 [3.63, 4.23]c
Perceived obviousness of Sofia and Daniel getting engaged in the future	2.95 [2.68, 3.22]a	3.69 [3.41, 3.97]b	4.66 [4.40, 4.92]c
Negative evaluation of the relationship ( $\alpha=.88$ )	4.43 [4.17, 4.69]a	3.45 [3.15, 3.75]b	3.01 [2.73, 3.29]b
Positive evaluation of the relationship ( $\alpha=.78$ )	3.44 [3.22, 3.66]a	4.19 [3.92, 4.46]b	4.64 [4.37, 4.91]c

Note. The six-month forecast was on an 11-point scale ranging from “they will have broken up” (scored as 1) to “they will have gotten engaged (scored as 11). All other items were rated on seven-point scales (surprising to obvious, strongly disagree to strongly agree). Broken Up (N=111), Control (N=108-109), Engaged (N=112-113).

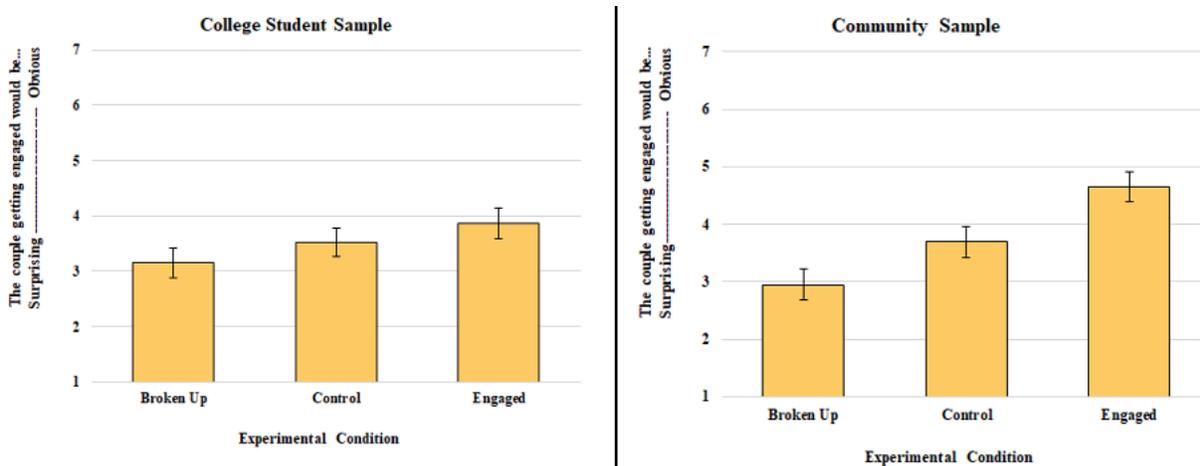
**Figure 1** Six-month forecast as a function of outcome knowledge.



**Figure 2** Perceived obviousness of breaking up as a function of outcome knowledge.



**Figure 3** Perceived obviousness of getting engaged as a function of outcome knowledge.



### Relationship Vignette

Each survey began with a description of Sofia and Daniel's relationship history. For this vignette, we listed the positives of their relationship and some potential downfalls. We randomly changed the order of the positives and negatives for counterbalancing purposes. The vignette is as follows:

Sofia and Daniel have just begun dating. It is their senior year of college and they hit it off after being introduced by a mutual friend at the homecoming football game.

The couple has some potential issues. Sofia is very religious and spends a lot of time with her campus ministry while Daniel is a firm disbeliever. They are also pursuing opposite careers. She aims to work for a nonprofit and he is majoring in finance. Because of these differences, they tend to hang out with different crowds and don't share a lot of friends. In fact, their friends don't really support their relationship. They think the relationship is moving too fast and that Sofia and Daniel are too into each other to recognize that they are on different life paths. For all of these reasons, when certain topics come up there is some tension between Daniel and Sofia.

However, the couple also has a lot going for them. They always have something to talk about and can be open and honest with each other without feeling judged. Daniel says that he has never felt so comfortable with a romantic partner. Sofia, too, feels secure and safe around Daniel. She goes to all of his soccer games and he surprises her with flowers and candy. They have many of the same hobbies, like camping, kayaking, and listening to live music. For all of these reasons, Sofia and Daniel have grown close very quickly. They spend hours talking about their possible future together – where they'll get married, their favorite baby names, and where they want to live."

This is how the vignette was presented for the control group. For the two experimental groups, participants were informed about the status of the couple's relationship six months later. For the broken-up group, participants are informed that six months later, Sofia and Daniel have broken up. For the engaged group, participants are informed that six months later, Sofia and Daniel have gotten engaged.

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## University Counseling Center Staff's Capability and Comfortability in Working with Students with Schizophrenia

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### Abstract

The aim of this research is to understand the capability and comfortability of college counseling center staff when working with students with schizophrenia. 34 college counseling center staff completed online surveys, and semi-structured interviews were conducted with four college counseling center directors. Questions focused on staff's perceived knowledge of treatments for schizophrenia, training experiences, attitudes, and comfortability working with such students. Independent samples t-tests were run between survey participants in high and/or low categories of knowledge. Participants reporting higher levels of knowledge reported higher levels of comfort treating students with schizophrenia ( $M=19.28$ ,  $SD= 1.78$ ) compared to those reporting lower levels of knowledge ( $M=14.94$ ,  $SD= 3.22$ ),  $t(32) = 4.8$ ,  $p < .001$ . There was no significant difference between knowledge groups on generalized stigma;  $t(32)= .562$  ( $p=.562$ ) or in social stigma scores,  $t(32) = 0.428$   $p = .780$ . Reoccurring themes, seen throughout the semi-structured interviews, consisted of university and family collaboration, experience working with students with serious and persistent mental illness (SPMI), concern for students, and a tailored approach. These results suggest that counselors who feel confident in their knowledge about schizophrenia feel more comfortable and prepared to work with such students.

### Introduction

While there is sufficient research regarding the prevalence and risk for psychosis in young adults (Jones et al., 2016), there is a lack of literature regarding schizophrenia targeted treatment in college counseling centers. Many university counseling centers are meant for short-term care, which does not align with the typical treatment plan for individuals with schizophrenia (Francis & Abbrassi, 2010). University counseling centers report 21% of students seeking services have a severe mental health concern, and three out of 1,000 students are diagnosed with schizophrenia (Mistler et al., 2012; Psychosis and Your College Student, 2017). Furthermore, first onset symptoms of schizophrenia, such as psychosis, tend to emerge around the traditional college-age, and students with psychiatric disorders are entering colleges at higher rates (Pedrelli et al., 2015,

Brady, 2007). As such, universities are often a first-line contact for treating students who experience these symptoms (Jones et al., 2016).

College students with schizophrenia often fare better when they have access to care and support on campus (Brady, 2008). It is important that college counseling centers are capable, and staff members are comfortable, working with students presenting such issues, as this additional support can help retain students, as well as guide them throughout their treatment process (Jones et al., 2016). Negative stigma associated with schizophrenia adds additional barriers for students with schizophrenia to adapt and thrive in a college setting, as a high percentage of individuals perceive those with schizophrenia to be dangerous or unpredictable (Silva et al., 2017, p. 2). Stigmas towards these individuals is common, and inadvertently affects relationships with potential employers or educators due to a lack of educational training (Smith et al., 2011, p.46). “Therapists’ belief in the potential of a recovery outcome for their patients is essential, even when the patients’ cognitions may be limited. Furthermore, training therapists how to treat and relate to symptoms of psychosis is paramount in improving the process of validating the patients’ experiences” (Miele, 2014, p. 60- 61).

In an attempt to fill the gap in current research, we investigated the following question through our research, “What factors about a university’s counseling center makes its staff feel better equipped and comfortable to serve the needs of students with SPMI?” Two hypotheses were developed at the start of this project: 1) the more knowledgeable counselors believe themselves to be about schizophrenia, the more comfortable they will be working with such students, and 2) the more knowledgeable participants report themselves to be about schizophrenia, the lower the stigma they will report towards students with schizophrenia.

## **Methods**

**Participants** Participants included 34 individuals (82% women, M age= 39.0) who work at a university counseling center. Of these participants, 85% identified as white, 9% mixed race, 3% Hispanic, and 3% Asian. The average length of time working in a counseling center was 10.9 years (SD = 8.9). Four current counseling center directors completed semi-structured interviews (M= 3.75 years being a counseling director). Gender and race are not reported to preserve confidentiality of counseling director participants.

**Procedures** A mixed methods approach, including a survey of counseling center staff and semi-structured interviews of counseling center directors, was used. Upon receiving approval to conduct this research from the University of Wisconsin-Eau Claire’s International Review Board, recruitment emails were distributed to 154 universities and college counseling centers throughout four midwestern states.

Survey: The names and contact information of counseling center directors at 154 universities and colleges throughout four midwestern states were obtained from campus websites. The directors were contacted via email and asked to a) participate in a brief

interview, and b) forward a link to the online survey to their staff. Staff completed the survey by clicking on a link included in the forwarded email. 154 reminders were requested, though it was unclear how many directors actually forwarded the survey participation request, so actual response rates are unknown.

**Interviews:** Of the 154 directors contacted, four agreed to complete semi-structured interviews. The interviews were conducted using the Zoom software platform and lasted between 30 minutes and 90 minutes. All participants were sent a recruitment email containing an informed consent document, where the purpose of the study and perceived benefits were detailed. Participants then responded to the email, indicating their interest in being interviewed. At the beginning of the interviews, verbal consent was obtained. Participants were asked if they were either 18 years of age or older, and if they consented being interviewed, and having their interviews recorded and stored for three years within the researcher's university secured OneDrive account. Recorded interviews were later transcribed using the Otter program, and data was analyzed through open-coding, allowing for common themes to be recognized.

### **Measures: Perceived Knowledge of Schizophrenia Treatment Strategies**

Questions were created for the purpose of the current study by reviewing best-practice guidelines for treating schizophrenia (Keepers et al., 2020). For example, participants were asked about cognitive behavioral therapy for schizophrenia, reality checking strategies, and crisis intervention for psychotic symptoms or the emergence of a psychotic break, and all items were responded to using a Likert-type scale ranging from “not at all” (0) to “very knowledgeable” (7). The internal consistency of these items was acceptable ( $\alpha = 0.919$ ), indicating reliability for use as a total perceived knowledge scale in analyses.

**Comfort Working with Students with Schizophrenia** Four questions were asked regarding participants' comfortability and preparedness in working with a student with schizophrenia. Possible answers ranged from “very uncomfortable” (1) to “very comfortable” (6). Higher scores on the scale indicated greater comfortability (minimum: 10, maximum: 21).

**Generalized and Social Stigma** Two concepts of stigma were included in the survey: the adapted versions of the Social Distancing Scale (SDS) and Semantic Differential Measure (SDM) (Broussard et al., 2012). The SDS measures the social distance, or comfortability of a relationship or proximity, the participant would like to be with a person with schizophrenia. Higher scores on the SDS (Broussard et al., 2012) corresponded with a greater level of comfort regarding those with schizophrenia and a lower level of social distance (minimum: 14; maximum: 29). The SDM compared participants' views of students with schizophrenia to an “average” student, by having them rate such students within the framework of polar adjectives of the extreme (worthless to valuable, dirty to clean, etc., minimum: 12, maximum: 84).

**Semi-Structured Interviews** Questions for the interview with directors were generated by reviewing research and best-practice guidelines for college counseling centers (Jones et al., 2016). These questions inquired about the typical protocol presenting symptoms of SPMI, specifically for schizophrenia, any training that is provided, and their perception of their staff's knowledge for working with students with SPMI (See appendix).

## Results

**Survey Results** To observe differences between participants who perceived themselves to be high or low in knowledge of treating schizophrenia, two groups were created using a median split based on the sample mean. Participants with perceived knowledge scores of 39 or greater were assigned to the high group ( $n = 16$ ) and those with scores of 38 or less were placed in the low group ( $n = 18$ ). Independent sample t-tests were conducted to examine group differences on comfort treating students with schizophrenia, generalized stigma, and social stigma scales.

Participants who reported higher levels of perceived knowledge also reported significantly higher levels of comfort treating students with schizophrenia ( $M=19.28$ ,  $SD= 1.78$ ) compared to those who reported lower levels of perceived knowledge ( $M=14.94$ ,  $SD= 3.22$ ),  $t(32) = 4.8x$ ,  $p < .001$ . Contrary to hypotheses, there was no significant difference between knowledge groups on the measures of generalized stigma;  $t(32)= 0.562$  ( $p = .562$ ). In addition, there was no significant difference in the social stigma scores between the knowledge groups,  $t(32) = 0.428$   $p = .780$ .

**Interview Themes** The themes of university and family collaboration, experience working with students with SPMI, concern for students and tailored approach were identified as a contributing factor for a counseling center's ability to meet unique needs of students with SPMI, and thus recognized as the four major themes from the semi-structured interviews. To describe and maintain the confidentiality of the participants' identities, they will be identified by the following; Case 1 (personal communication, June 15, 2020) has a PhD in Counseling Psychology and works at a midsized university; Case 2 (personal communication, June 22, 2020) has a PhD in Clinical Psychology and works at a small private college; Case 3 (personal communication, August 13, 2020) is a licensed master social worker at a tertiary educational institution; Case 4 (personal communication, September 11, 2020) has a PhD in Clinical Psychology, and works at a small private college.

**University and Family Collaboration** University collaboration refers to the counseling centers' involvement with other student services on campus, in regard to a student's mental health or concern over their wellbeing (Jones et al., 2016). When asked about collaboration with student services, all participants indicated interest or relationships with their university's disability, health, housing, and multicultural services. Case 2 went on to say that "we're (the counseling center) going to involve as many individuals on campus as we need to" (personal communication, June 22, 2020). Additionally, the

two directors at private colleges, Case 2 (personal communication, June 22, 2020) and Case 4 (September 11, 2020), offered unique connectedness by working alongside the Campus ministry. However, Case 3 (personal communication, August 13, 2020) discussed experiencing difficulty forming healthy communication between counseling services and disability services, explaining that confidentiality and a lack of understanding created obstacles for the two departments to work together in managing student issues and concerns.

Family interventions are considered best practice in the treatment plan of an individual with schizophrenia (Caquera et al., 2015) and greatly encouraged amongst this clinical population (Pedrelli et al., 2015). These interventions often include therapy sessions with the client and their immediate family members, which can help promote open communication between all. These sessions are largely based on family collaboration with the client's treatment team, with the goal of involving the students' main caregivers or support system (Caquera et al., 2015). Notably, family intervention cannot be forced upon student clients in university counseling centers. Case 1 (personal communication, June 15, 2020) stated that "we (the counseling center) would never surprise someone with a family session or something like that without their (the student's) permission. It would always be led by that student." All counseling center directors indicated interest or current/past work with families and students, but prior to contacting families, student consent must be obtained. For some, including family members can be an obstacle in treatment, whether through administration's concern or a student's refusal for consent. Ultimately, family interventions were described as positive when the student was fully consenting and eager to bring in family members to their sessions.

**Experience Working with Students with SPMI** This theme relates not only to a participant's graduate education and training focus, but the amount of interaction they have had with students with SPMI in their counseling centers. Participants education and training varied and those with Clinical Psychology degrees received more experience studying and working with individuals with SPMI, while counseling and other helping degrees work with "healthier, less pathological populations" (Norcross, 2000). Every participant had different experiences with students with a SPMI, and the average amount of students they work with who have a SPMI ranged from 10-25% of their students. When asked how many students with diagnosable schizophrenia they have worked with, the number decreased to one to three students in their career. These results suggest counseling staff most certainly interact with students with SPMI and led to inquiring about continuing education requirements. All participants reported that themselves and their staff were able to choose which courses to register for based on personal preferences. Case 3 explained difficulty finding continuing education that focused on SPMI, "that (continuing education) would arm me with the appropriate response to treat somebody on site a plan to get them treatment. And it's maddening, I cannot find anything" (personal communication, August 13, 2020).

Recent research has suggested that graduate and medical students experience additional academic pressure, and are often unable to take time off from their responsibility of classes, research, clinical practicum, etc. (Dyrbye et al., 2005 & Woolston, 2019). Case 3 displays the reality of students with SPMI attending their university's rigorous tertiary school, stating the number of students with SPMI was, "probably pretty low only because they wouldn't make it here... You have people who are quite frankly, higher functioning" (personal communication, August 13, 2020). However, Case 3 explained that while students may not fit a diagnosis for schizophrenia, for example, they seem to exhibit extreme signs of perfectionism and neuroses. Perfectionism has been found to hinder academic performance and raise stress levels in medical students, indicating a need for accessible and comprehensive mental health services (Bußenius & Harendza, 2019). While students in post-graduate programs indicate a need for mental health services, many, especially medical and dental, may be hesitant to disclose and seek help regarding their mental illness (Bianchi et al., 2016).

**Concern for Students** The theme, "concern for students", references how counseling center directors follow up or check-in on students who have indicated that they are a threat to themselves or others, or if someone reports concern for a student. Every participant explained that if a faculty member, student or parent reached out to them with concerns for a student, they would be comfortable contacting such students. Three universities had a specific procedure for such instances, where a team of staff members, from various student services, come together to review cases and indications of concern for a student. Case 2 explained, "it's either consulting with us (the counseling center) directly, they can just give us a call, or they can fill out a form which could be anonymous, or they could give their personal information" (personal communication, June 22, 2020). Early intervention and detection of SPMI symptoms is crucial in ensuring an individual's chances of successful treatment, and measures used at universities can help identify students at risk and connect them with the appropriate support (Christianson, 2019).

**Tailored Approach** Tailored approach refers to a university counseling centers' ability and willingness to create a unique treatment plan that fits the needs of a student, and often incorporates collaboration with other university or outside services. All participants indicated their counseling centers have or would utilize an individualized approach for students experiencing SPMI (Jones, et al., p. 26). "There's no one treatment to all, it's collaborating to meet their needs," (Case 1, personal communication, June 15, 2020) This can be actualized by advocating for unique academic accommodations, creating a safety plan, referring students to an outside counselor, using unique techniques, etc.

For instance, universities that had nurse practitioners or medical doctors employed in campus medical centers were able to offer medication management for students, with the expectation of a signed waiver (Case 1, personal communication, June 15, 2020 & Case 4, personal communication, September 11, 2020). Additionally, the ability to offer regular and frequent sessions for students was found within the counseling centers of Case 2

and Case 3. The National Association on Mental Illness – Southwest Washington chapter reports that many students are subjected to their counseling centers' waitlists, which can harm their own mental health (Thielking, 2017). For mid-sized public universities, like Case 1's, pairing monthly or bi-weekly sessions with an outside clinician's assistance provides robust support and services for students with SPMI.

## **Discussion**

The survey findings indicate that those who reported higher scores of perceived knowledge also reported higher levels of comfort working with students who have schizophrenia; however, there were no meaningful differences regarding generalized or social stigma. The results highlight the importance of ensuring college counseling center staff are trained and receive continuing education on how best to work with students who have schizophrenia. Contrary to hypotheses, there were not meaningful differences regarding generalized or social stigma between the perceived knowledge groups. These results suggest counselors who feel confident in their knowledge about students with schizophrenia also feel more comfortable and prepared to work with such students. This comfort and preparedness may relate to better therapeutic relationships and student outcomes (Brady, 2008). Additionally, the current results suggest knowledge does not relate to generalized or social stigma about individuals with schizophrenia.

The themes discovered from the semi-structured interviews display which factors in a university counseling center influence its ability to work with students with SPMI. Participants indicated various strategies and resources in place to meet the needs of such students, in addition to extents to which they can be truly capable. Findings from interviews were consistent with expected practices at university counseling centers (Jones et al., 2016).

This project is not exempt from limitations, as a notable obstacle was the survey's sample size, as participation recruitment occurred in the midst of the COVID-19 pandemic. The majority of university counseling center staff are not contracted during the summer months, which possibly interfered with the response size. The majority of participants identified as white, which displays the lack of racially/ethnically diverse participants. Reliability of survey responses is another limitation, as truthfulness relied entirely on the participants themselves.

Further research is needed to examine how and if stigma interferes with the therapeutic relationships and client outcomes. While counselors in college settings are not consistently exposed to students with schizophrenia, results from this study indicate that many perceive themselves to be knowledgeable and comfortable working with such students. These findings are promising as they suggest universities may be equipped and adequately capable to work with students who are diagnosed with schizophrenia. This study encourages further research to examine how and if stigma interferes with the therapeutic relationships and client outcomes.

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