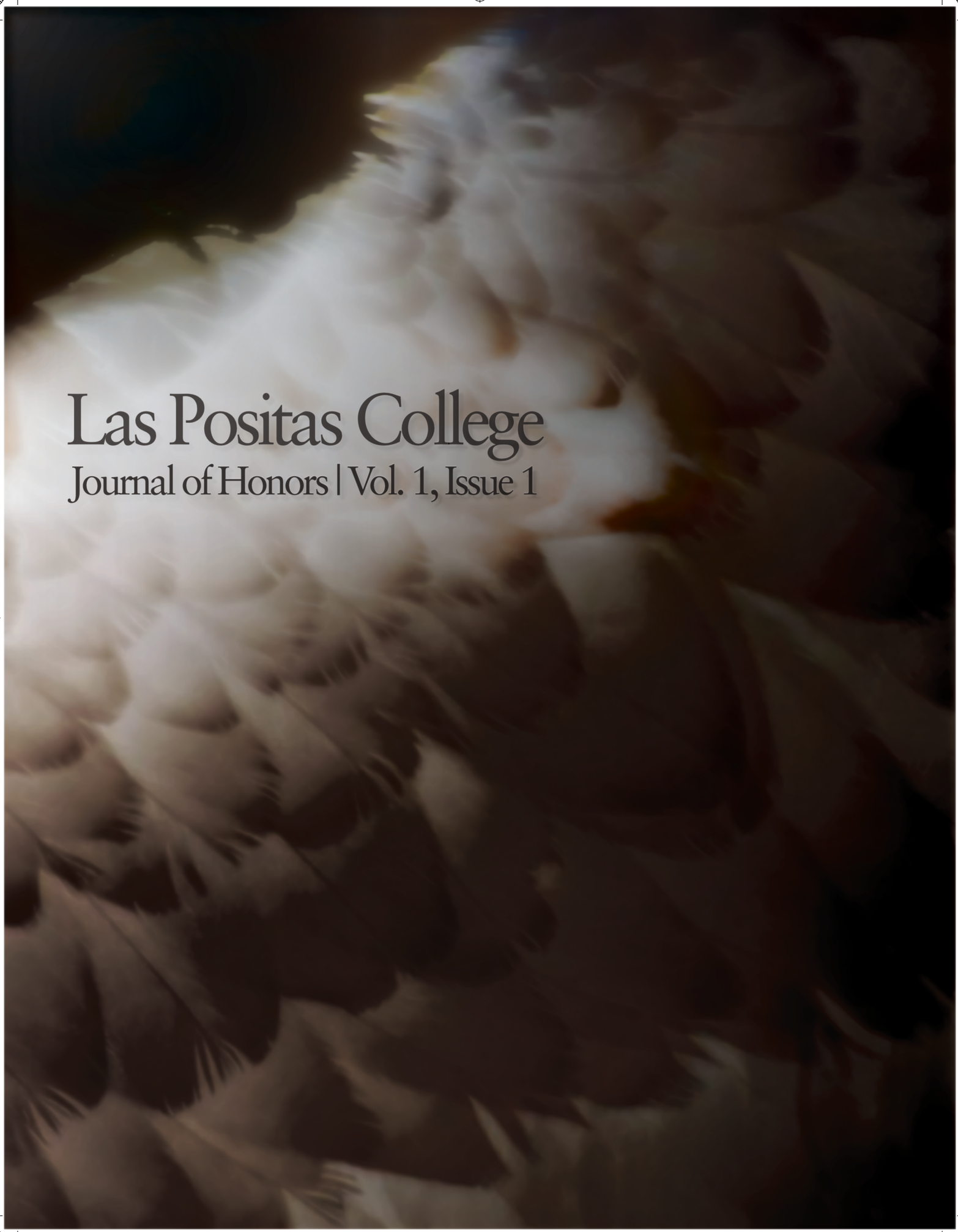

Las Positas College

Journal of Honors | Vol. 1, Issue 1

Letter from the editor

Dear reader,

It is with great pride that we present the first issue of the Las Positas College Journal of Honors.

This first release represents not only the founding of this journal, but also the continuing development of Las Positas College into a community that highlights academic scholarship and growth across all disciplines. Few community colleges across the nation offer a platform for their students to publish their research, if at all even providing their students with the opportunity to produce it. At Las Positas College, honors students have displayed their ability to find the gaps within academia, as well as their capacity to develop unique solutions to fill these gaps.

We established this journal with the goal of giving students at Las Positas College a platform for their research completed through the LPC Honors Program. Community College students often experience a limited environment — one of travel between just their home and the classroom. LPCJH staff are extremely grateful to be part of a community at Las Positas College where a nationally esteemed student life and highly regarded academic prowess are institutional hallmarks. Launching a journal has tested the ability of our staff in administrative and technical ability, and an exceptional standard has certainly been set for future cohorts.

As Editor-in-Chief, I hope that this publication represents the beginning of a lasting organization at Las Positas College which encourages expanding intellectual capacity and resolve. We are proud to share this first issue with you, and are even prouder of what it represents: the growing intellectual atmosphere of Las Positas College.

Arya Ferozy
Editor-in-Chief
Las Positas College, Journal of Honors
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Volume 1, Issue 1 | Spring 2026

Theory vs Reality: Evaluating the Computational Quantum Chemistry Predictions of Greenhouse Gas Infrared Spectra

Abigail Brandel

Las Positas College '26

ABSTRACT

Climate change is driven by the accumulation of greenhouse gases (GHGs) that absorb infrared (IR) radiation and trap heat in Earth's atmosphere. Understanding these vibrational transitions therefore becomes important for quantifying the radiative forcing of different gases, as well as predicting their contributions to global warming. While the infrared spectroscopy of major GHGs is well understood, isolating gases for spectroscopy can be an expensive and timely process. This study uses computational analysis to analyze the IR spectra of the following major GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxides (NO and NO_2), and water vapor (H_2O). Molecular structures were built and optimized in Avogadro, then exported to ORCA 5.0 for quantum chemical calculations. Infrared spectra were computed using Density Functional Theory (DFT) with the B3LYP functional and 6-31G* basis set. Results show strong alignment between both computational and experimental data, with computational absorbances on average being slightly higher as a result of various approximations during calculations. Ultimately, through comparison of both computationally-generated and experimentally-determined absorption bands with Earth's emitted IR radiation, this project evaluates not only similarities across GHG absorbances, but the accuracy and limitations of computational methods: demonstrating how theoretical chemistry can complement experimental spectroscopy in atmospheric and climate research.

INTRODUCTION

Climate change: one of the most pressing scientific and societal challenges of the 21st century. Driven by the rapid accumulation of greenhouse gases (GHGs) in the atmosphere, climate change leads to rising global temperatures, sea level increase, and extreme weather events that threaten ecosystems and human communities worldwide. GHGs in the Earth's atmosphere trap infrared (IR) radiation, which increases the vibration of molecules on our planet and can be felt as an increase of heat.

The ability of a molecule to absorb and re-emit IR light depends on its vibrational motions; i.e., for a molecule to absorb IR light, the frequency of the light must match the natural frequency of a specific bond's vibration.[1] When IR photons excite vibrational modes that involve a change in the molecule's dipole moment, energy is absorbed and re-emitted, effectively retaining heat within the troposphere. Understanding these vibrational transitions therefore becomes important for quantifying the radiative forcing of individual gases, as well as predicting their contributions to global warming.[2] By connecting molecular-scale vibrational dynamics to large-scale climate effects, IR spectroscopy provides a powerful framework for understanding the physical chemistry underlying greenhouse potential.

The quantum chemistry computational approach relies on the principles of quantum mechanics to describe and predict the behavior of molecules at the atomic level. It utilizes mathematical equations and wavefunctions, such as the Schrödinger equation, to determine how electrons are distributed throughout a system.[3] Determination of this electron distribution can help inform us on a molecule's properties.

However, solving the Schrödinger equation exactly is only possible for very simple systems like hydrogen. As a molecule or compound's complexity increases, fso does the computational intensity. As a result, quantum chemistry employs a variety of approximation methods to make these calculations feasible for larger molecules. Among these methods, Density Functional Theory (DFT) is one of the most widely used, as it provides a good balance between computational cost and accuracy.[4] DFT models the total energy of a system as a function of the electron density, rather than compiling electron wavefunctions for every single electron in a system.[4]

While DFT is the theoretical framework that the calculations are based on, the accuracy of results depends on two main choices: the functional and the basis set. In this work, all calculations are performed through ORCA using the hybrid functional B3LYP in combination with the 6-31G* basis set, a well-established model for predicting vibrational frequencies and molecular geometries — optimized especially well for small and organic molecules.[4] It is important to distinguish between the functional and the basis set in a quantum chemistry calculation. The functional (B3LYP) defines how electronic energy is modeled within Density Functional Theory by approximating electron exchange and correlation. The basis set (6-31G*) provides the mathematical functions used to represent atomic orbitals and electron density. Essentially, the functional determines how energy is calculated, while the basis set determines the accuracy with which the molecular orbitals are described.[4]

When performing these calculations, you may also often hear of the "harmonic approximation" step. The reason behind this is that when quantum chemistry programs like ORCA calculate vibrational frequencies, they assume that molecular vibrations behave like harmonic oscillators, meaning the potential energy increases symmetrically as atoms move away from equilibrium.[4] This simplification, known as the harmonic approximation, allows the vibrational problem to be solved computationally. However, in reality, the vibrations can be anharmonic, moving asymmetrically for a wide and unpredictable range of reasons that can't exactly be factored into a mathematical equation.

Because of this approximation, DFT-calculated frequencies are usually slightly higher than experimental values. This overestimation arises because the harmonic model assumes perfectly parabolic oscillations (symmetrical), while actual molecular vibrations experience flatter, anharmonic oscillations.[5] To correct for this, researchers apply empirical scaling factors to the computed frequencies. Kesharwani et al.[5] recommends a scaling factor of 0.9679 for B3LYP/6-31G* to bring theoretical predictions into close agreement with experimental IR spectra.

In this work I plan to use Avogadro, a free 3D modeling software, to first build and visualize the following five molecules: carbon dioxide (CO_2), methane (CH_4), nitrous oxides (NO and NO_2), and water vapor (H_2O). To obtain a realistic starting geometry for quantum calculations, each molecule will be subjected to a molecular mechanics geometry optimization. These 3D optimized structures will then be exported from Avogadro

into ORCA 5.0, a quantum chemistry program. I will run ORCA to computationally determine the IR spectrum. All calculations will be performed using Density Functional Theory (DFT) with the B3LYP functional and 6-31G* basis set. Through analyzing each molecule's strongest bands of absorption in comparison to the heat wavelengths Earth emits, I will determine the greenhouse gas potential of each molecule.

II. METHODS

Each molecule was built in Avogadro (version 1.2.0), a free 3D modeling software. To obtain a realistic starting geometry for quantum calculations, each molecule was subjected to a molecular mechanics geometry optimization within Avogadro. From there, I obtained the Cartesian coordinates of each atom, saving the file to be used with ORCA.

Density functional theory (DFT) calculations were performed using the ORCA quantum chemistry software package (version 6.1.0). The geometry of each molecule was optimized using the B3LYP hybrid functional in combination with the 6-31G* basis set. After optimization, a harmonic vibrational frequency analysis was carried out to confirm that the optimized structure corresponded to a true minimum and to obtain infrared (IR) vibrational frequencies and intensities.

All calculations were executed locally on a Windows machine using the ORCA command-line interface. The resulting output files included information about the molecule's IR spectra. To ensure compatibility with molecular visualization software, the output file was converted to UTF-8 encoding. The IR spectrum was subsequently generated and visualized using a Python script to generate the graph, which utilized the frequency and intensity values from the IR spectra.

III. RESULTS

Carbon dioxide (CO2):

The computationally generated CO2 IR spectrum displays a strong absorption band at 2469 cm^{-1}; also displays an absorption band at 652 cm^{-1} (Figure 1).

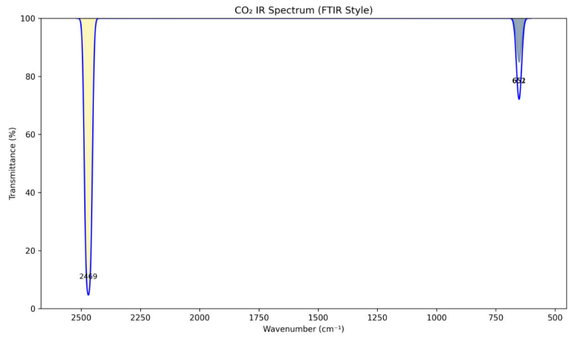

Figure 1. Computationally-generated CO2 IR spectrum. Displays a strong absorption band at 2469 cm^{-1}, corresponding to the asymmetric stretching vibration. Also displays an absorption band at 652 cm^{-1}, which likely represents the bending vibration. As expected for a linear, centrosymmetric molecule, the symmetric stretch is IR-inactive and does not appear in the spectrum.

The accepted CO2 IR spectrum data from the National Institute of Standards and Technology displays a strong absorption band at around 2400 cm^{-1}; also displays an absorption band at approximately 600 cm^{-1} (Figure 2).

Water vapor (H_2O):

The computationally-generated IR spectrum of water vapor shows three prominent peaks

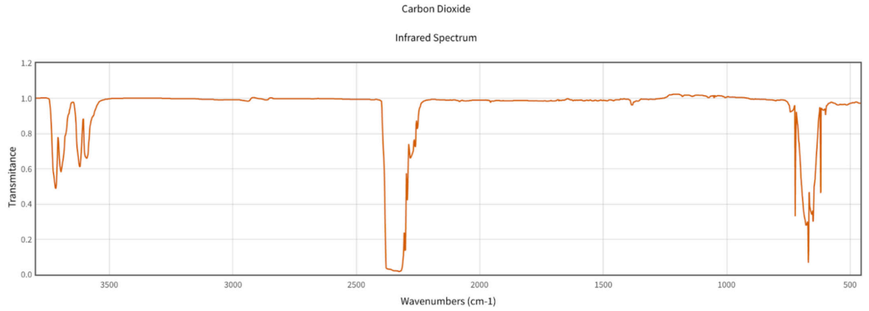

Figure 2. Accepted CO2 IR spectrum data from the National Institute of Standards and Technology. Displays a strong absorption band at around 2400 cm^{-1}, corresponding to the asymmetric stretching vibration. Also displays an absorption band at approximately 600 cm^{-1}, which likely represents the bending vibration. The symmetric stretch is IR-inactive and does not appear in the spectrum.

(Figure 3). At 3882 cm^{-1} and 3787 cm^{-1}, two vibrations are observed; additionally, a strong absorption in the mid-IR region occurs at 1637 cm^{-1} (Figure 3).

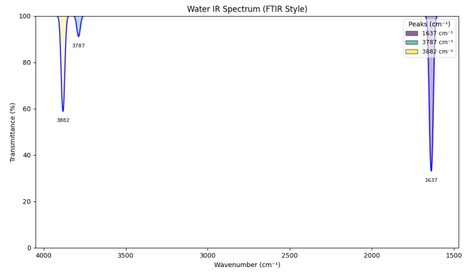

Figure 3. Computationally-generated IR spectrum of water vapor, with three prominent peaks. At 3882 cm^{-1} and 3787 cm^{-1}, two O–H stretching vibrations are observed, with the former appearing as the dominant peak. These are likely symmetric and asymmetric stretches. A strong absorption in the mid-IR region occurs at 1637 cm^{-1}, likely representing the H-O-H bending vibration.

The accepted water vapor IR spectrum data from the National Institute of Standards and Technology also shows three prominent peaks: from 3800-3600 cm^{-1}, two peaks are seen; another peak is also seen around 1500–1600 cm^{-1} (Figure 4).

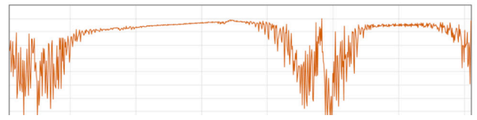

Figure 4. Accepted water vapor IR spectrum data from the National Institute of Standards and Technology. From 3600-3800 cm^{-1}, two peaks are seen in this IR-active range, likely corresponding to the O-H symmetric and asymmetric stretches. Around 1500-1600 cm^{-1}, another peak is seen, likely representing the H-O-H bending vibration.

Methane (CH_4):

The computationally-generated methane spectrum shows a broad, intense band centered near 3152 cm^{-1}; and a second feature at 1313 cm^{-1} (Figure 5).

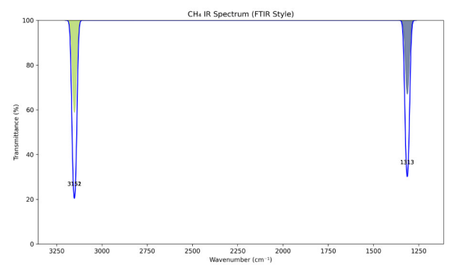

Figure 5. Calculated methane FTIR spectrum. A broad, intense band centered near 3152 cm^{-1} corresponding to the C-H stretching vibrations, and a second feature at 1313 cm^{-1}, which likely represents a bending vibration.

The accepted methane IR spectrum data from the National Institute of Standards and Technology displays an absorption band at around 3000 cm^{-1}; it also displays an absorption band at approximately 1250–1300 cm^{-1} (Figure 6).

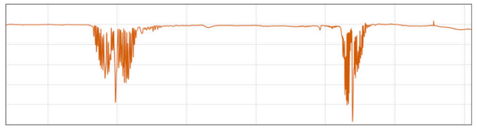

Figure 6. Accepted methane IR spectrum data from the National Institute of Standards and Technology. Displays an absorption band at around 3000 cm^{-1}, corresponding to the C-H stretching vibrations. Also displays an absorption band at approximately 1250-1300 cm^{-1}, which likely represents the bending vibrations (both symmetric and asymmetric).

Nitric oxide (NO):

The calculated nitric oxide FTIR spectrum produces a single dominant IR absorption at 2040 cm^{-1} (Figure 7).

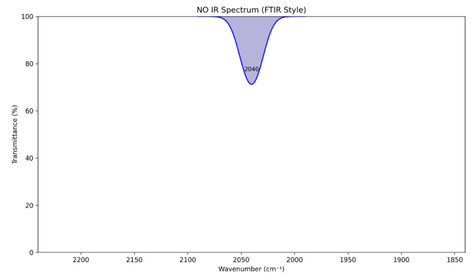

Figure 7. Calculated nitric oxide FTIR spectrum. Nitric oxide produces a single dominant IR absorption at 2040 cm^{-1}, corresponding to its fundamental N–O stretching vibration. No additional peaks appear, consistent with NO having only one vibrational degree of freedom.

The accepted nitric oxide IR spectrum data from the National Institute of Standards and Technology also produces a single dominant IR absorption at approximately 1900 cm^{-1} (Figure 8).

Figure 8. Accepted nitric oxide IR spectrum data from the National Institute of Standards and Technology. Nitric oxide produces a single dominant IR absorption at approximately 1900 cm^{-1}, corresponding to its fundamental N–O stretching vibration. No additional peaks appear, consistent with NO having only one vibrational degree of freedom.

Nitrogen dioxide (NO_2):

The calculated nitrogen dioxide FTIR spectrum has three major peaks: at 894 cm^{-1}, 1314 cm^{-1} and 3479 cm^{-1} (Figure 9).

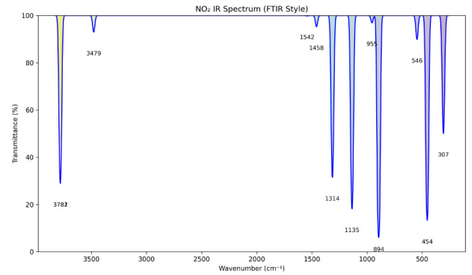

Figure 9. Calculated nitrogen dioxide FTIR spectrum. The major peak at 894 cm^{-1} likely corresponds to NO2's bending vibration. Similarly, the peak at 1314 cm^{-1} likely represent the NO2 asymmetric stretching frequency. The highest-frequency absorption, seen at 3479 cm^{-1}, likely corresponds to an overtone.

The experimental comparison for the nitrogen dioxide IR spectrum, determined and analyzed by Robert V. St. Louis and Bryce Crawford, also displays three major peaks: at 750 cm^{-1}, 1618 cm^{-1}, and 2901 cm^{-1} (Figure 10).

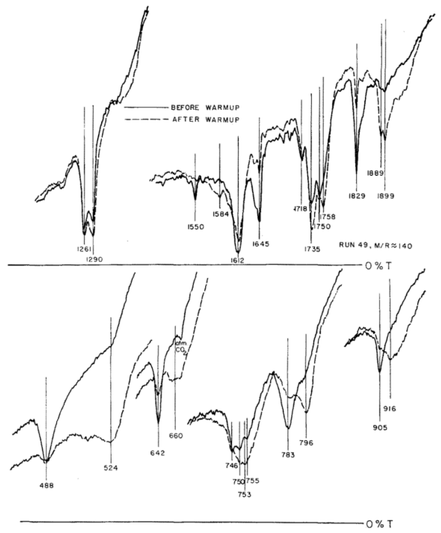

Figure 10. Nitrogen dioxide IR spectrum, determined and analyzed by Robert V. St. Louis and Bryce Crawford. The most notable peaks: a strong gas-phase N02 asymmetric stretching frequency at 1618 cm^{-1}. The peak at 750 cm^{-1} is due to N02's bending vibration. The highest frequency absorption is seen at 2901 cm^{-1}, and likely corresponds to an overtone. An unobserved symmetric stretching fundamental was also expected to lie near 1318 cm^{-1} (St. Louis & Crawford, 1965).

IV. DISCUSSION

Analyzing Earth's thermal emission peak, it can be seen that Earth's thermal emission peaks near ~600 cm^{-1} (≈15–17 μm), with substantial emission across the 500–1500 cm^{-1} range, explaining why greenhouse gases with absorption bands in this region are particularly effective at trapping heat (Figure 11). This provides a basis for systematically assessing the heat-trapping potential of each gas molecule based on the alignment of its IR absorption bands with Earth's emission profile.

Carbon dioxide (CO2):

The computationally generated CO2 IR spectrum displays an absorption band at 652 cm^{-1}, agreeing with the accepted band approximately 600 cm^{-1}; these bands likely represent the bending vibration for O-C-O (Figures 1 and 2). This absorption is particularly significant in terms of heat capture: it happens to align with the major ~600 cm^{-1} peak in Earth's blackbody spectrum, which is the IR wavelength the Earth emits most intensely.[6] As a result, CO_2 is very effective at trapping infrared radiation because this absorption band overlaps with Earth's strongest heat emissions.

The computationally generated CO_2 IR spectrum also displays a strong absorption band at 2469 cm^{-1}, agreeing with the accepted band at around 2400 cm^{-1}; this corresponds to the asymmetric stretching vibration (Figures 1 and 2). However, this 2350-2450 cm^{-1} (4.3 μm) asymmetric stretch is not significant in terms of global warming because Earth emits very little radiation at this wavelength.[6] The symmetric stretch for CO2 is IR-inactive and does not appear in either spectrum, as expected for a linear, centrosymmetric molecule.

Water vapor (H2O):

The computationally-generated IR spectrum of water vapor shows two peaks at 3882 cm^{-1} and 3787 cm^{-1}, agreeing with two accepted peaks seen at approximately 3800 and 3600 cm^{-1}; these peaks represent two O–H stretching vibrations – likely symmetric and asymmetric stretches (Figures 3 and 4). Additionally, the computationally-determined spectra shows a strong absorption at 1637 cm^{-1}, agreeing with an accepted peak around 1500–1600 cm^{-1}, likely representing the H-O-H bending vibration (Figures 3 and 4).

Zhong and Haigh[6] show that water vapor has strong absorption in many regions of the

IR spectrum: when water vapor is removed, the outgoing IR flux increases significantly across a broad range of wavenumbers (Figure 11). Figure 11 (b) shows removing H_2O (red line) causes large negative dips across wide regions, meaning that the general absorption capabilities of water vapor are responsible for making it a very potent and effective greenhouse gas. Overall, this data shows that water vapor is able to act as a potent greenhouse gas by absorbing broadly across much of the infrared spectrum, particularly at lower wavenumbers near Earth's emission peak.

Methane (CH4):

The computationally-generated methane spectrum shows a broad, intense band centered near 3152 cm^{-1} corresponding with an accepted band at around 3000 cm^{-1}; representing the C-H stretching vibrations (Figures 5 and 6). A second feature on the computational spectrum is seen at at 1313 cm^{-1}, agreeing with an accepted absorption band at approximately 1250–1300 cm^{-1}; likely representing the asymmetric and symmetric bending vibrations (Figures 5 and 6). Methane's capacity to exist as a greenhouse gas is evident, as outgoing IR flux increases when it is removed (Figure 11). In particular, methane's bending vibrations are likely what makes it a potent greenhouse gas, as a strong heat-capturing vibration exists at 8 µm, which corresponds to ~1250 cm^{-1}.[6] These significant absorption bands absorb incoming solar 'shortwave' radiation, and contribute to radiative forcing.[1]

Nitric oxide (NO):

The calculated nitric oxide FTIR spectrum produces a single dominant IR absorption at 2040 cm^{-1}, agreeing with an accepted single absorption peak at approximately 1900 cm^{-1}; this corresponds to the fundamental N–O stretching vibration (Figures 7 and 8).

No additional peaks appear on either spectrum, consistent with NO having only one vibrational degree of freedom. As a result, although nitric oxide exhibits an IR-active N–O stretching vibration, it is not considered a greenhouse gas because its absorption band does not overlap with Earth's thermal emission peak (Figure 11). This highlights our ability to analyze what IR-active bands a gas would require in order to trap heat in Earth's atmosphere: allowing us to predictively analyze any gases we may unintentionally create as byproducts for their potential as greenhouse gases.

Nitrogen dioxide (NO2):

Nitrogen dioxide is not a heat-trapping gas – not to be confused with the potent greenhouse gas, nitrous oxide, or N_2O_7. Thus, while NO_2 is seen to have IR-active vibrational modes, none were expected to heavily absorb wavelengths within Earth's thermal emission spectrum.[8] The calculated nitrogen dioxide FTIR spectrum has three major peaks. The peak at 894 cm^{-1} , agreeing with an accepted peak at 750 cm^{-1} (Figures 9 and 10) likely corresponds to NO_2's bending vibration8. Similarly, the computational peak from 1542–1314 cm^{-1} agree with an accepted peak seen at 1618 cm^{-1} (Figures 9 and 10), which likely represent the NO2 asymmetric stretching frequency.[8] The computational highest-frequency absorption at 3479 cm^{-1} agrees with an accepted absorption seen at seen at 2901 cm^{-1} (Figures 9 and 10); this likely corresponds to an overtone.[8]

Earth's thermal emission peaks at around 600 cm^{-1} and ranges from 500–1500 cm^{-1} (Figure 11). Although nitrogen dioxide exhibits IR-active modes that partially overlap with Earth's thermal emission range, its absorption bands are relatively weak, not centered at the emission peak, and its low atmospheric abundance and short lifetime limit its overall greenhouse impact. In comparison to the IR-active modes of CO_2, H_2O, and CH_4, NO2's absorption bands are much weaker with softer peaks. Nitrogen dioxide is considered a minor greenhouse gas not due to its heat-trapping ability, but because of its tendency to react with other atmospheric chemicals to produce particulate matter and ozone.[7]

V. CONCLUSION AND FURTHER DISCUSSION

Across all five molecules, all five had calculated infrared spectra that aligned properly with their experimentally-determined infrared spectra. From computation alone, the three greenhouse gas molecules (CO_2, H_2O, and CH_4) were correctly identified as GHGs that actively contribute to the trapping of infrared radiation in our planet. Nitric oxide and nitrogen dioxide were non-heat-trapping gases that were included as negative controls – similar to nitrous oxide, a prominent GHG — and were computationally determined to not have the same IR-active bands as any of the heat-trapping gases. What we can determine from analysis across all five molecules is that heat-trapping gases have strong IR-active absorptions within Earth's thermal emission peak: the mid-infrared region where Earth emits strongly, which shows around 500–1500 cm^{-1}. Higher-frequency bands, like those seen in NO and NO_2, have little-to-no greenhouse potential, as these bands do not align with Earth's range of heat emissions. In addition, a visible pattern is that many greenhouse gases tend to have bending modes with low frequencies, have asymmetric stretching modes that fall inside the thermal IR window, and be nonlinear: providing them with more vibrational degrees of freedom.

All computational IR spectra were generated using mathematical calculations that approximate vibrations as perfectly parabolic oscillations. Because of this approximation, DFT-calculated frequencies are on average slightly higher than actual experimental values, as true molecular vibrations experience flatter, anharmonic oscillations5. With this knowledge in mind, the slightly higher frequencies for all the computational peaks in comparison with accepted values are understandable. After applying this correction factor, wavenumbers are lower, and closer to their actual experimental value.

Importantly, in evaluating the reliability of these results, it is important to consider both systematic and random sources of error. Systematic errors arise primarily from the harmonic approximation used in DFT calculations, which consistently overestimates vibrational frequencies. The computational pipeline also does not take into account the fluctuation of real atmospheric conditions, such as temperature and pressure, which may contribute to deviation from experimental values. Small random errors may result from numerical precision limits, convergence thresholds, and uncertainties in experimental reference spectra. Despite these limitations, the overall conclusions remain robust, as the distinction between mid-infrared absorptions characteristic of greenhouse gases and higher-frequency modes observed in non-greenhouse molecules is significantly larger than the expected computational error. Therefore, while absolute frequencies may vary slightly, the qualitative identification of greenhouse behavior is not affected.

These studies as a whole demonstrate the accuracy of computational chemistry in determining stable and optimal molecular structures, as well as calculating the infrared absorbances of gaseous molecules. Going forwards, it is clear that computational chemistry is a valuable, time-saving, and cost-effective tool that can complement experimental spectroscopy in atmospheric and

climate research. In the future, testing the accuracy of infrared absorbance calculations on more structurally complex molecules would be valuable in determining how well computational methods hold up against traditional experimental methods when the molecular structure itself is harder to navigate. A potential future direction of this research would be to integrate computational chemistry methods with real-time atmospheric monitoring data, allowing for dynamic modeling of molecular behavior under changing environmental conditions. By combining predictive simulations with experimental datasets, researchers could refine existing models to better account for temperature fluctuations, pressure variations, and intermolecular interactions present in the atmosphere. This approach could improve the accuracy of climate models, and eventually serve to enhance our understanding of how trace gases contribute to radiative forcing and long-term climate change.

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Effects of Olive Leaf and Black Seed Extracts on Lettuce (Lactuca sativa) Germination Under Salt Stress

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ABSTRACT

Soil salinity serves as a primary obstacle that decreases agricultural output by stopping seed germination through its impact on osmotic pressure, its creation of harmful ions, and its induction of oxidative stress. This study tested the capacity of olive leaf extract from Olea europaea and black seed extract from Nigella sativa to reduce salt stress damage on lettuce germination and early root growth. The research employed a 3 × 3 factorial design, which combined three NaCl concentrations of 0, 50, and 100 mM with three treatment types of water, olive leaf extract, and black seed extract. The researcher conducted a seed growth experiment lasting 11 days in a greenhouse to monitor germination count and mean root length as their main outcome indicators. Olive leaf extract showed complete suppression of germination across all salinity conditions, because its phenolic compounds, oleuropein and hydroxytyrosol, display documented allelopathic properties. The black seed extract allowed only minimal germination of 1 to 2 seeds per section at all salinity levels; yet the seedlings that developed under 100 mM NaCl had longer roots, with a mean length of 6.0 mm, compared to water controls, which had a mean length of 2.6 mm at the same concentration. The water controls achieved the best overall germination results, which included an unexpected high count at 100 mM NaCl due to a counting error and the gradual occurrence of late germination. The results demonstrate that undiluted whole plant extracts receiving daily applications will not act as biostimulants under these conditions; instead, they will either restrict or have little impact on seed germination. Future work should test various diluted extract concentrations, seed priming methods, and complete design replication to assess the agricultural potential of these culturally significant plants.

INTRODUCTION

Soil salinity is one of the most important non-living factors that negatively affect agriculture. The presence of dissolved salts, especially sodium chloride (NaCl), at very high concentrations, makes it difficult for seeds to absorb water, causes disturbance in the ion balance, and leads to oxidative damage of cells. The cumulative effect of these processes can either slow down or totally stop the germination process. Since seeds and the youngest seedlings rely only on the very limited stored nutrients and have not yet developed the full rooting system, they are very prone to the environmental stress of the extreme condition[1].

Salinity acts on seeds by at least three different mechanisms. The first one is the osmotic stress that occurs when the soil solution's water potential becomes so low that seeds cannot take up enough water during imbibition. The second mechanism is ionic stress, which occurs because tissues

build up excessive Na^+ and Cl^-. The third mechanism is oxidative stress which results from salt stress because it generates reactive oxygen species (ROS) that lead to cell membrane destruction and protein and nucleic acid (DNA) destruction. Rahimi et al.[2] found that in Nigella sativa, salinity greatly increases the Na^+ content and at the same time lowers K^+, thus changing the Na^+/K^+ ratio to levels that not only inhibit enzyme activities but also cell growth. Other oil crops and small-seeded species have also been reported to exhibit similar trends[3]. Lettuce (Lactuca sativa) is a salt-sensitive plant species which scientists use to study how germination and allelopathy affect its physiological processes. Lettuce germination and seedling development show an inverse relationship with increasing salt levels according to multiple studies, and stress effects can be partially reversed through pre treatments or hormones or biological extracts.[4,5]

Agricultural research has shifted in focus to natural biostimulants, mostly plant material that help in fighting salinity along with other environmental stressors which have been rising in numbers due to climate change. Biostimulants are substances that stimulate plant growth through a more efficient nutrient uptake and higher resistance to stress without relying on conventional fertilizer or pesticide means. In light of this, numerous chemical compounds that have different purposes such as phenolics, flavonoids, terpenes, alkaloids, and other secondary metabolites that act as antioxidants, signaling molecules, and mild growth regulators are studied for in plant extracts for scientific purposes. The olive tree (Olea europaea) leaves offer a rich source of phenolic compounds which include oleuropein and hydroxytyrosol and verbascoside. Zaïri et al.[6] demonstrated that olive leaf extract demonstrates two different biological activities which include its ability to stop seed germination of test species through its antioxidant effects and its allelopathic properties. The study with faba beans showed that olive leaf extract improved plant growth under salt stress conditions by increasing chlorophyll content and antioxidant enzyme activity at the proper dilution level.[7] The research found opposing results because the two main factors which determine olive extract effects on plants are dosage and plant species sensitivity. Black seed (Nigella sativa) has been a major ingredient in traditional medicine and is culturally significant in many Muslim communities. The seeds and oil of the plant contain thymoquinone and nigellone in addition to flavonoids which provide both antioxidant and cytoprotective effects. Ahmadian et al.[8] reported that poor germination results under saline conditions could be significantly improved by pre-treating N. sativa seeds with hydropriming and osmopriming. Papastylianou et al.[1] indicated that germination capacity and seedling length decreased with increasing NaCl concentrations, but that proper seed treatments could alleviate the effects to some extent.

The principal question addressed in this study was whether olive leaf extract or black seed extract would enhance lettuce seed germination and early root growth under saline conditions. The hypothesis was that both extracts would increase germination percentage under salinity compared to water alone, and that treated seeds would develop longer roots, showing better early vigor, based on literature citing both the negative effects of salinity on germination[1-3] and the potential for plant extracts and priming treatments to mitigate stress.[4,8]

II. METHODS

This study was based on a 3x3 factorial design implemented to evaluate the combined effect of salinity and plant extract treatments on germination and root development of lettuce seeds. Two factors were involved: Salinity (NaCl level) at 0 mM (control), 50 mM, and 100 mM; and treatment type: plain water, olive leaf extract, and black seed extract. A section of a seed tray was designated for each combination of treatment and salinity. The initial design required every section to have four seeds but all sections except one had four seeds while one water section with 100 mM NaCl needed five seeds because of a counting error. The study commenced on Day 0 which was a Friday when seeds were planted and treatments began and it concluded the following week on Tuesday. Sodium chloride NaCl was used to create salinity for the experiments. Solutions were prepared through distilled water which contained the following concentrations 0 mM NaCl which contained only distilled water and 50 mM NaCl which contained 2.92 g NaCl per liter and 100 mM NaCl which contained 5.84 g NaCl per liter. The fine-mist spray bottle was tested by measuring its delivery volume after 10 sprays which resulted in a delivery of 15 mL. The salt solution was applied through 10 sprays which delivered approximately 15 mL to each tray section on Day 0. The same amount of salt solution from Day 3 was applied again to control salt levels at a stable point without creating extra salt buildup or leaching. The study assessed two different plant extracts which included olive leaf extract from Olea europaea leaves and liquid black seed extract from Nigella sativa seeds. The extracts were applied directly to the soil surface which was next to the seeds without further dilution. Each tray section assigned to an extract treatment received four drops per day of its respective extract, starting on Day 0 after the salt solution and continuing daily throughout the study. Water control sections did not receive any plant extract. A homogeneous seed-starting soil mixture was used to fill commercial seed-starting trays. Each section was marked according to its salinity and extract treatment. Lettuce (Lactuca sativa) seeds were spread throughout the soil in every section of their study area. The trays were placed inside a greenhouse which maintained a temperature of 24°C and used a lighting schedule that provided 16 hours of light and 8 hours of darkness. Distilled water was used to water all sections of the study area because the soil needed to be kept moist for germination while preventing excessive watering and water runoff. Germination was monitored throughout the entire period but they only recorded official measurements after the census period ended on the tenth day. A seed was marked as germinated if the radicle (embryonic root) was clearly visible. Millimeter measurements were used to record the radicle length of each plant which they obtained by carefully extracting it from the soil.

III. DATA

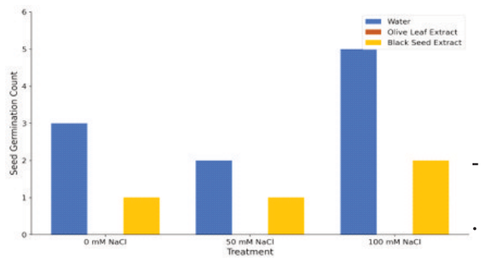

Figure 1. Germination counts by treatment and stability.

Germination was strikingly different between the treatments. At every salt level, the extract from olive leaves led to no germination at all. The water treatment resulted in the highest germination rate overall, including an unexpected increase at 100 mM NaCl. Black seed extract produced very low germination (1–2 seeds) at all salinity levels.

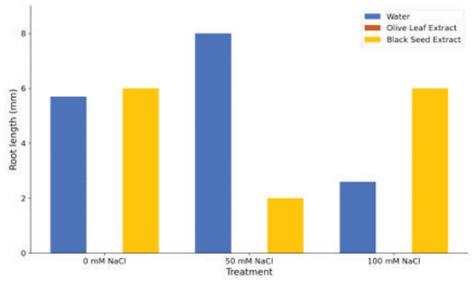

Figure 2. Mean root length(mm) by treatment and salinity.

The patterns of root length were influenced by both the treatment and salinity. Water-treated seedlings were longest at 50 mM NaCl, but root length dropped sharply at 100 mM. Black seed extract seedlings produced roots of moderate length at 100 mM. No olive extract root data were available since no seeds germinated.

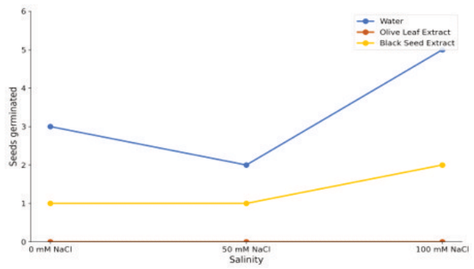

Figure 3. Germination counts across NaCl level for each treatment.

The interaction plots highlight that the treatments were clearly separated. The use of olive leaf extract did not vary with salinity, as there was no germination under any condition. Water and black seed treatments both enabled germination which produced the highest results through water treatment and black seed achieved consistent but minimal germination.

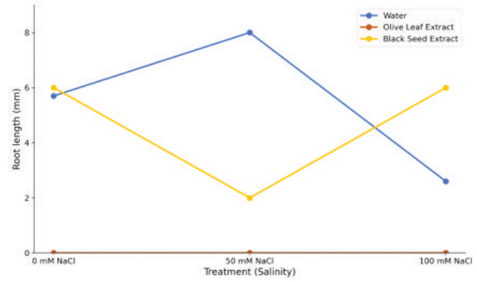

Figure 4. Mean root length(mm) across NaCl levels for each treatment.

Interactions related to root length exhibited that water-treated seedlings had a decrease in root length at higher salinity, while black seed extract produced comparatively longer roots under 100 mM NaCl. Olive extract data remained at zero because no seeds germinated.

IV. RESULTS

The extract treatment had a strong influence on germination, while salinity had a lesser effect. The most remarkable pattern was the sections that received olive extract treatment showed no germination results at all three NaCl concentration levels (0, 50, and 100 mM NaCl).

The water control had the highest amount of germination across all test conditions. Three seeds showed successful germination at the 0 mM NaCl concentration. Two seeds showed germination at 50 mM NaCl concentration. The 100 mM NaCl test produced five seeds that germinated.

Black seed extract permitted only very low germination at all salt levels. At 0 and 50 mM NaCl, one seed germinated in each section.

At 100 mM NaCl, two seeds germinated in the black seed section.

Root length considerations create a more complex picture. The water-treated seedlings showed mean root length measurements which reached their highest point at 0 mM NaCl with a value of 5.7 mm and increased to 50 mM NaCl, where roots reached approximately 8.0 mm, before dropping to 2.6 mm at 100 mM NaCl. The 100 mM salinity level showed a decline because more seeds at this level showed successful germination yet their roots grew shorter which matched the known negative impact of salinity on root growth and cell development.

In the case of seedlings treated with black seed extract, the sample sizes were small, but mean root length was relatively long (approximately 6.0 mm) at 100 mM NaCl, based on two seedlings with roots of 7 and 5 mm respectively. At 50 mM NaCl, the only black seed seedling that germinated had a 2 mm root. No root data were available from black seed treatment at 0 mM, as the single seedling was not recorded or for root olive extract at any salinity, since no seedlings germinated.

V. DISCUSSION

This research aimed to study the effects of olive leaf extract and black seed extract simultaneously on germination and root growth of lettuce seedlings under salt stress conditions. The main observations were: olive leaf extract completely blocked germination regardless of salinity; black seed extract produced seedlings with relatively good root length but low germination at 100 mM NaCl; and water controls yielded the highest germination at 100 mM NaCl but produced the shortest roots at that concentration.

The results did not confirm the initial prediction that both extracts would have a positive impact on germination rates under salt stress. Instead, olive extract functioned as a very strong allelochemical inhibitor, and black seed extract only showed very slight benefits after germination.

Complete germination failure in olive-treated sections was consistent with the identified allelopathic traits of olive leaf phenolics. Zaïri et al.[6] showed that the oleuropein and hydroxytyrosol content in olive leaf extract can inhibit seed germination in other plant species. Lettuce is known to be extremely susceptible to allelopathic agents, which is why it is often used as an indicator plant in such studies[9]. The undiluted extract applied as daily drops presumably led to very high local concentrations of these compounds around the seeds.

In contrast, a study with faba beans reported beneficial activity from olive leaf extract when applied at a defined concentration in irrigation water, enhancing chlorophyll content and antioxidant enzyme activity under salt stress[7]. The contrasting outcomes are likely explained by dosage and plant species differences: faba beans may tolerate or even benefit from certain phenolic concentrations, while lettuce embryos appear inhibited even at the same or higher concentrations.

Black seed extract had no significant effect on the germination process; only 1 to 2 seeds germinated in each section. This compares unfavorably with studies where black seed treated with water or osmotica improved germination percentage and root length under salt stress.[1,8] Those studies showed that black cumin seeds derived their benefits from priming, suggesting that the method of application may matter as much as the extract itself. The black seed treatment resulted in low germination rates but produced remarkable results through their extended root growth which occurred in 100 mM NaCl conditions. The sample size remained insufficient yet the water-treated

seedlings at identical salt levels showed root length averaging 6.0 mm which exceeded double the measurement. The black seed contains thymoquinone together with other antioxidants that have the potential to prevent oxidative damage[10]. Oxidative stress is one of the key factors stunting root growth under high salinity[2]. The black seed extract treatment might have protected the root meristems of the surviving seedlings because it led to greater root growth than water controls at identical stress levels. The limited number of experiments conducted makes this interpretation necessary to treat with caution.

One unexpected result was that water controls showed the highest germination count at 100 mM NaCl rather than at 0 or 50 mM. Most studies report a gradual decrease in germination with rising salinity[1-3]. The slightly higher seed count in that section (five instead of four), slower but eventual germination due to osmotic adjustment, possible microenvironmental variation in that part of the tray, and potential genetic variation in commercial seed lots may all have contributed to this outcome.

The significant reduction in root length at 100 mM NaCl, despite higher germination counts, corroborates that salinity remained a major stressor. Delayed germination with stunted seedling growth under high salinity has been reported in lettuce and other species[4,11].

VI. LIMITATIONS

The major limitations of this study are: a small sample size which requires one tray section to test each treatment combination because it contains only 4 to 5 seeds together with the high extract concentration which uses daily application frequency that most farmers probably would not apply in their work and there was an absence of any biochemical data which would have demonstrated how results connected to established scientific mechanisms through Na^+/K^+ ratios and antioxidant enzyme activities.[2,7] The future work should use treatment design which includes multiple replicates to test various extract dilutions while evaluating seed priming against both soil and foliar application methods. Future research would benefit from testing additional species to measure their physiological responses through proline accumulation and antioxidant enzyme activity assessments.[3,4]

VII. CONCLUSION

This research project was carried out to establish the effects olive and black seed extracts have on germinating and growing lettuce seeds in saline conditions. Findings indicate that daily undiluted application of olive leaf extract blocked germination completely at all salinity levels, an indication of strong allelopathic or toxic effects on the lettuce embryos. Black seed extract gave low germination but roots were relatively long in 100 mM NaCl, with an implication of protection of root length by the extract against high salt stress. Water controls showed that lettuce seeds can still germinate at 100 mM NaCl, but root growth is inhibited.

In summary, this research indicates that plant extracts of cultural and medicinal importance do not necessarily produce positive outcomes for all crops. Their effects vary depending on plant species, concentration, and method of application. While olive and black seed extracts may still have potential as biostimulants at lower doses or in different formats, this experiment highlights the necessity of careful optimization and replication of procedures before any recommendations for agricultural use can be made. The hypothesis that both extracts would increase germination percentage and root

length under salinity was not supported; however failure to confirm this hypothesis still gave valuable insights into plant stress physiology.

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Evaluating Mechanical and Fire-Resistance Tradeoffs in Thermoplastics Using Statistical Methods

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ABSTRACT

Thermoplastics are widely used in engineering due to their ease of manufacturing and tunable mechanical properties. However, real-world material selection requires balancing performance criteria. A key engineering challenge is balancing mechanical performance with fire resistance. This study evaluates whether measurable relationships exist between mechanical and fire-related properties across commonly used thermoplastic families. Data was collected from manufacturer datasheets and public engineering materials databases across several thermoplastic families, including ABS, PLA, PC, PP, PA, and PET/PETG. Mechanical properties analyzed include tensile strength and impact resistance, while fire-related properties include UL-94 flammability classification (UL-94), Limiting Oxygen Index (LOI), and Heat Deflection Temperature (HDT). Statistical methods include descriptive statistics, Pearson correlation analysis, and analysis of variance (ANOVA) to investigate relationships across materials. Results show weak, inconsistent correlations between mechanical and fire-related properties across individual materials. However, observable differences emerge when materials are grouped by polymer family, suggesting that polymer structure plays an important role in performance tradeoffs than simple pairwise correlations. To address the limitations of interpreting individual fire metrics independently, this paper introduces a conceptual Fire-Resistance Proxy Score (FRPS) that combines multiple fire-related measurements into a single screening-level metric. The FRPS integrates LOI, UL-94, and HDT through a normalized composite metric for early-stage material screening. While not a substitute for fire testing, this approach provides a framework for comparing materials. Implications for additive manufacturing and engineering material selection are discussed. Due to the dataset's size and variability in datasheet sources, the findings should be interpreted as exploratory and warrant further study.

1. INTRODUCTION

Thermoplastics are widely used in modern engineering due to their relatively low cost, versatility, and ability to tailor mechanical and thermal properties through formulation and processing. These materials are used in a wide range of applications, including consumer electronics housings, automotive components, and structural parts. Thermoplastics used in additive manufacturing environments present an especially interesting case because they must simultaneously satisfy mechanical durability, processing stability, and fire safety requirements.

However, in many applications, engineers must balance competing performance requirements. Mechanical performance, such as tensile strength and impact resistance, must often be weighed against safety characteristics such as fire resistance. For example, materials used in electrical housings must maintain structural integrity while also minimizing ignition risk and flame propagation.

The relationship between mechanical properties and fire resistance in polymers is not straightforward. Some formulations designed to improve fire performance negatively affect mechanical performance, while others maintain or even improve certain mechanical properties. Because these relationships depend on polymer structure, additives, and processing conditions, identifying broad statistical patterns across materials can provide useful insights for material selection.

This study investigates whether statistical correlations between mechanical properties and fire-related metrics can reveal underlying drivers of material behavior in commonly used thermoplastics. Given the variability in material datasets and limited sample size, this study emphasizes exploratory statistical relationships rather than definitive conclusions. Understanding these relationships is increasingly important as polymers move from purely consumer applications toward structural, electrical, and safety-critical environments. In addition to examining correlations between individual properties, the study also evaluates differences across polymer families. Because multiple interacting structural and formulation variables govern polymer performance, statistical analysis provides a useful framework for identifying patterns across material datasets. Three primary research questions guide the analysis:

- Do mechanical properties correlate with fire-related metrics across thermoplastics?
- Do these properties differ significantly across polymer families?
- Are existing fire-resistance metrics sufficient on their own, or would a combined metric better represent fire performance?

2. LITERATURE REVIEW

In polymer engineering, materials are often chemically modified to meet specific fire safety requirements. However, literature consistently shows that flame retardancy represents a constrained multi-objective optimization problem. Improvements in properties such as ignition resistance, self-extinguishment, dripping behavior, smoke or toxicity generation, and heat release frequently compete with processability and mechanical performance; this limits the design space available to engineers.[4]

Empirical studies of flame-retardant polymer systems show that improving fire performance can influence multiple aspects of material behavior, including degradation pathways, molecular weight distribution, filler–matrix compatibility, and polymer morphology. These changes can subsequently affect mechanical properties such as stiffness, tensile strength, and particularly toughness or impact resistance, even when fire performance improves.[1,8]

However, this design space is not absolute. Certain additive systems and synergistic flame-retardant formulations can maintain impact properties while still improving fire performance. As a result, mechanical–fire relationships should be interpreted as conditional material trends rather than universal material laws; polymer chemistry, additive interactions, and processing conditions all influence the outcome.[8,15]

By applying statistical methods to real materials data, this project demonstrates how statistical analysis can support engineering decision-making. More broadly, the analysis illustrates how relatively simple statistical tools can reveal patterns in engineering

materials datasets that are often hidden when properties are considered individually. Given the variability in material datasets and limited sample size, this study emphasizes exploratory statistical relationships rather than definitive conclusions.

2.1 Mechanical-Fire Performance Tradeoffs

Polymer fire performance can be affected by the incorporation of flame-retardant additives or by structural modifications to the polymer itself. These changes can alter the material's degradation behavior, molecular structure, or crystallinity.

In many cases, fire-resistance improvements can affect mechanical performance. For example, certain flame retardants may alter filler dispersion or interfere with polymer chain mobility, thereby reducing impact resistance or toughness.

However, empirical studies demonstrate that this relationship is not universal. Some flame-retardant systems maintain mechanical performance while improving fire resistance, particularly when synergistic additives or optimized polymer formulations are used. Therefore, the relationship between fire performance and mechanical properties depends strongly on the chemical and structural properties of the polymer system under study.

2.2 Limitations of Common Fire Metrics

Several standardized metrics are commonly used to assess the fire behavior of polymers; however, each measurement reflects only one aspect of fire performance.

The UL-94 test evaluates how polymer samples behave when exposed to a small flame under controlled laboratory conditions. The test classifies materials based on burning behavior, dripping, and self-extinguishment time. However, UL-94 classifications are not intended to predict real-world fire behavior and are sensitive to factors such as specimen thickness, geometry, and processing conditions.[9,11,12]

The LOI measures the minimum oxygen concentration required to sustain flaming combustion. LOI is expressed as a percentage of oxygen in a controlled test environment. Although LOI provides a continuous and easily comparable metric, it does not describe flame spread dynamics or fire growth behavior.[3,6]

The HDT measures the temperature at which a polymer deforms under an applied mechanical load. HDT, therefore, represents thermomechanical stability rather than combustion behavior. Because HDT values depend on testing stress levels and experimental methods, comparisons across datasets require careful interpretation.[7]

These limitations indicate that individual fire metrics should not be interpreted in isolation. Instead, they are best viewed as screening indicators that capture different aspects of material performance.

2.3 Polymer Family Structure-Property Relationships

Thermoplastic families exhibit systematic differences in mechanical and thermal behavior because of their underlying molecular structures. Polymer chain architecture, intermolecular forces, and crystallization behavior all influence mechanical strength and thermal stability.

For example, PLA generally exhibits lower heat resistance due to slower crystallization kinetics and lower glass transition temperatures[2]. In contrast, engineering thermoplastics such as PC demonstrate greater thermomechanical stability due to higher glass transition temperatures and stronger intermolecular interactions.[10]

Other thermoplastics such as PP, nylon (PA), and PET exhibit distinct combinations of stiffness, toughness, and thermal resistance[5]. These structural differences suggest that material comparisons should be interpreted within polymer families rather than across unrelated materials.

Grouping thermoplastics by family therefore provides a more meaningful framework for analyzing performance patterns within engineering materials datasets.

2.4 Composite Fire Metrics

Because no single measurement fully describes fire behavior, some research approaches combine multiple fire-related variables into composite indices. These indices are typically used for comparative ranking rather than absolute prediction of fire performance.

For example, cone calorimetry-based indices such as the Flame Retardancy Index (FRI) integrate multiple fire parameters into a single comparative metric.[13] These approaches recognize that fire behavior is influenced by multiple interacting variables rather than a single descriptor. Building on this idea, this study proposes a conceptual FRPS. The FRPS combines three available fire-related descriptors: (1) LOI, (2) UL-94, and (3) HDT.

The FRPS, therefore, functions as a screening-level composite metric that integrates oxygen threshold behavior, ignition and self-extinguishment characteristics, and thermomechanical heat tolerance. Importantly, the FRPS does not represent true fire resistance. Instead, it provides a consistent comparative indicator designed for exploratory statistical analysis across thermoplastic families within the constraints of the available dataset.

3. DATA AND MATERIALS

Data used in this analysis were compiled from publicly available engineering materials databases and manufacturer technical datasheets. These datasheet values represent standardized laboratory measurements commonly used by engineers for preliminary material screening before detailed fire testing. Data sources included engineering materials databases such as MatWeb, as well as manufacturer technical documentation. The dataset includes several commonly used thermoplastic families:

- Acrylonitrile Butadiene Styrene (ABS)
- Polylactic Acid (PLA)
- Polycarbonate (PC)
- Polypropylene (PP)
- Nylon: Polyamide (PA), including PA6 and PA66
- Polyethylene Terephthalate (PET) and Polyethylene Terephthalate Glycol (PETG)

The final dataset contained 18 material grades across six polymer families, with between two and four representative grades per family depending on data availability. Because datasheet values represent single reported measurements rather than distributions, variability within each material grade could not be directly captured.

Material properties were collected from manufacturer datasheets and engineering materials databases, then standardized to consistent units for comparison. The dataset includes mechanical and fire-related screening indicators commonly reported in polymer datasheets, including tensile strength, impact resistance, LOI, UL-94, and HDT.

Missing values were recorded where properties were not reported in the original datasheets. Differences in testing standards, specimen preparation methods, and reporting formats were also documented to ensure transparency when interpreting the compiled dataset.

4. METHODS

4.1 Descriptive Statistics

Descriptive statistics were calculated for each numerical property, including mean and standard deviation. These statistics provide an overview of property distributions across the dataset and establish a baseline understanding of variation within the collected materials data.

4.2 Data Visualization

Several visualizations were used to explore relationships between variables. Visualization plays an important role in exploratory data analysis because many material relationships are easier to interpret when trends and variability are portrayed graphically. These visualizations were used primarily used to identify potential patterns before formal statistical testing.

Scatterplots comparing mechanical and fire metrics

Boxplots comparing property distributions across polymer families

Correlation heatmaps summarizing relationships among variables

4.3 Correlation Analysis

Pearson correlation coefficients were calculated to evaluate linear relationships between mechanical and fire-related variables. Although correlation does not imply causation, it provides a useful first-order indicator of whether two variables tend to increase or decrease together across the dataset. Because multiple interacting structural and formulation variables govern polymer performance, statistical analysis provides a useful framework for identifying patterns across material datasets. Pearson correlation was used under the assumption of approximate linear relationships between variables.

4.4 Hypothesis Testing

Analysis of variance (ANOVA) was used to evaluate whether mechanical and thermal properties differed significantly across polymer families. ANOVA was selected because it allows comparisons of mean values across multiple categorical groups, assuming approximate normality of residuals and independence of observations. Given the exploratory nature of the dataset and the moderate sample sizes across polymer families, ANOVA provides a reasonable statistical framework for detecting group-level differences. Statistical significance was evaluated at $\alpha = 0.05$.

Before conducting ANOVA, key assumptions were evaluated. Independence was assumed based on the dataset's structure, where each material corresponds to a distinct observation. Approximate normality of residuals was assessed using visual inspection of distributions, and homogeneity of variance was evaluated through comparison of group spreads. Given the exploratory nature of the dataset and relatively small sample sizes, minor deviations from these assumptions were considered acceptable.

4.5 Data Limitations

The dataset used in this analysis was compiled from manufacturer technical datasheets and publicly available engineering materials databases. While these sources are used in engineering practice for preliminary materials selection, they introduce limitations that affect data reliability and comparability.

First, datasheet values are reported under controlled laboratory conditions and may represent optimized or idealized performance rather than real-world behavior. Manufacturers tend to report values that reflect favorable testing conditions, which can introduce bias when comparing materials across different sources.

Second, inconsistencies in testing standards and reporting conditions limit comparability between materials. For example, HDT values depend on applied stress conditions, and impact resistance values may be reported using different testing methods (e.g., Izod vs. Charpy, notched vs. unnotched). Although efforts were made to standardize units and select comparable values, these differences introduce variability that may weaken statistical relationships.

Third, UL-94 classifications represent categorical ratings rather than continuous measurements and are sensitive to specimen geometry, thickness, and testing setup. Converting these classifications into numerical values for analysis introduces an additional layer of approximation, potentially reducing the precision of derived metrics such as the FRPS.

These factors indicate the dataset should be interpreted as a collection of standardized but imperfect screening-level indicators rather than fully controlled experimental measurements. As a result, observed statistical patterns may reflect both underlying material behavior and variability introduced by differences in data sources.

Given that the dataset includes a limited number of grades per polymer family (typically 2–4), variability within each group may not fully capture the range of commercially available formulations.

5. RESULTS AND DISCUSSION

5.1 Overview of Relationships

Initial analysis reveals substantial variability across materials. Mechanical properties analyzed include tensile strength (MPa) and impact resistance (kJ/m^2), while thermal behavior is represented by heat deflection temperature (°C). Some materials have high tensile strength but low fire-related metrics, whereas others have low tensile strength but higher fire-related metrics.

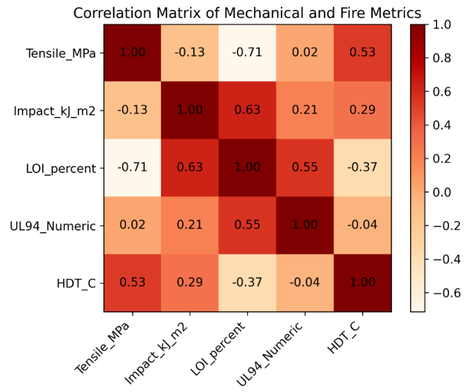

Figure 1. Correlation heatmap showing relationships between mechanical properties and fire-related metrics across thermoplastic materials.

The correlation matrix indicates that mechanical properties and fire-related metrics do not show strong linear correlation within this dataset. However, these patterns should be interpreted in the context of dataset limitations, including variability in datasheet sources and measurement conditions.

5.2 Mechanical vs Fire Metrics

Scatterplots comparing tensile strength and LOI show large variation with no clear linear relationship.

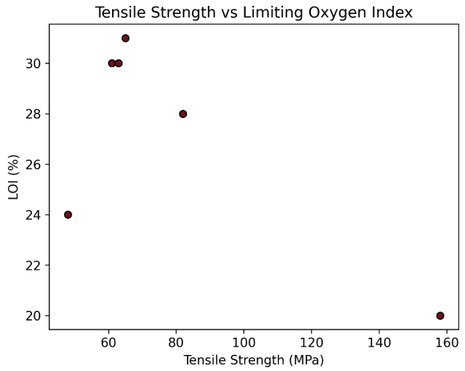

Figure 2. Scatterplot showing the relationship between tensile strength and limiting oxygen index (LOI) across thermoplastic materials.

Similarly, impact strength and LOI show weak correlation, suggesting that increased fire resistance does not consistently correspond to reduced toughness across materials.

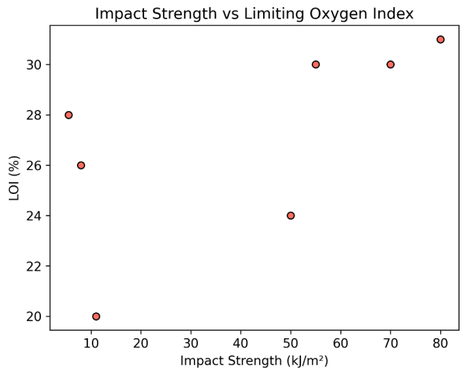

Figure 3. Scatterplot showing the relationship between impact strength and limiting oxygen index (LOI) across thermoplastic materials.

While pairwise scatterplots reveal weak relationships between individual variables, grouping materials by polymer family reveals clearer structural patterns in both mechanical and thermal behavior.

5.3 Polymer Family Differences

When materials are analyzed individually, relationships are weak or inconsistent. When materials are grouped by polymer family, clearer quantitative patterns emerge in both mechanical and thermal properties. In the present dataset, impact strength varies substantially across families, ranging from 6 kJ/m^2 for nylon materials to roughly 68 kJ/m^2 for polycarbonate, with intermediate values observed for ABS (~14 kJ/m^2), PLA (~16 kJ/m^2), polypropylene (~21 kJ/m^2), and PET-based materials (~22 kJ/m^2). Thermal resistance shows a similarly wide range across families. Average heat deflection temperature spans from approximately 55°C for PLA to more than 130°C for polypropylene, with polycarbonate (~125°C) and PET-based materials (~118°C) also demonstrating significantly higher thermal stability than ABS (~70°C) and nylon (~65°C).

These differences suggest underlying structural characteristics between the polymers. Polycarbonate has high impact resistance due to its aromatic backbone and high glass transition temperature, which promotes energy absorption before fracture. On the other hand, the nylon grades in the dataset have lower impact values, possibly reflecting moisture sensitivity and differences in crystallinity that influence fracture behavior. Thermal resistance is also closely tied to polymer structure. We see that materials such as polypropylene, polycarbonate, and PET have higher HDTs due to greater molecular rigidity or higher thermal transition temperatures. In contrast, PLA exhibits lower heat tolerance due to its relatively low glass transition temperature and slower crystallization kinetics.

Taken together, the results suggest that polymer family classification can help capture meaningful structural effects that influence mechanical strength and thermal stability. Rather than linear pairwise correlations between properties, the dataset shows us that broader structural characteristics of polymer families play a larger role in determining performance tradeoffs across thermoplastics.

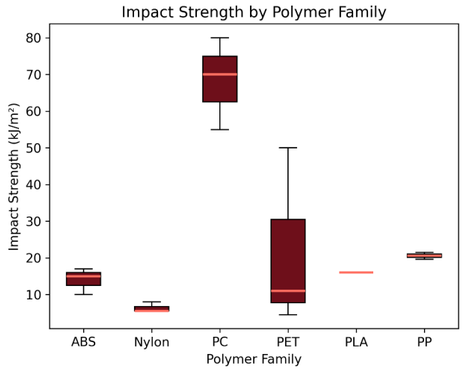

Figure 4. Boxplot comparing impact strength distributions across thermoplastic polymer families.

Polycarbonate shows the highest impact resistance in the dataset, with values ranging from approximately 55 to 80 kJ/m^2 and a median near 70 kJ/m^2, indicating consistently high toughness across grades. In contrast, nylon materials exhibit much lower impact values, clustered around 5-8 kJ/m^2, suggesting comparatively brittle behavior under notched impact conditions. ABS materials fall in an intermediate range, with impact strengths between 10 and 17 kJ/m^2. Polypropylene materials exhibit somewhat higher values, typically around 20–22 kJ/m^2, while PLA shows relatively stable values near 16 kJ/m^2 in the available dataset.

PET-based materials demonstrate the greatest variability, with impact strengths ranging from approximately 4.5 to 50 kJ/m^2, reflecting the presence of both standard PET grades and modified PETG formulations that significantly enhance toughness. This large spread indicates that formulation differences within a polymer family can strongly influence impact performance.

These patterns reflect fundamental differences in structure and deformation mechanisms. Overall, the results demonstrate that polymer family classification strongly influences impact behavior, with engineering thermoplastics, such as polycarbonate, showing substantially greater toughness than commodity polymers, such as PLA or ABS, in the present dataset.

Thermal behavior also differs across polymer families.

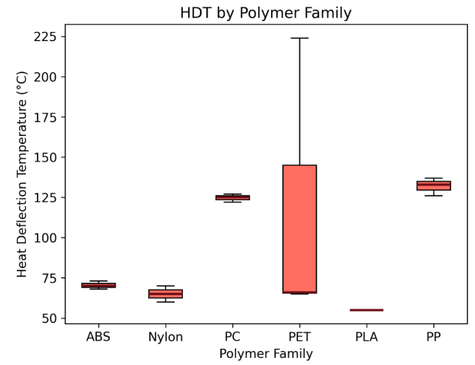

Figure 5. Boxplot comparing heat deflection temperature (HDT) across thermoplastic polymer families.

HDT also varies substantially across polymer families in the dataset. PLA has the lowest thermal resistance with an HDT at 55°C under the tested conditions. ABS and nylon exhibit moderately higher HDT values, generally ranging from 60 to 73°C. In contrast, engineering thermoplastics such as polycarbonate and polypropylene demonstrate significantly higher heat resistance. Polycarbonate grades cluster around 122–127°C, while polypropylene materials show

HDT values between approximately 126–137°C.

PET-based materials exhibit the greatest variability in the dataset, with HDT values spanning from approximately 65°C to over 220°C. This wide range reflects the presence of both standard PET formulations and reinforced engineering-grade PET materials, which can dramatically increase thermal stability.

These differences arise from fundamental polymer structure and thermal transition behavior. Materials such as polycarbonate and PET contain rigid aromatic structures and higher glass transition temperatures, allowing them to maintain stiffness at elevated temperatures. Polypropylene achieves a relatively high HDT due to its semicrystalline morphology, which improves thermal stability compared to amorphous polymers. In contrast, PLA exhibits a lower HDT due to its lower glass transition temperature and slower crystallization rate, which limit its ability to retain stiffness at elevated temperatures.

Overall, the results indicate that polymer family strongly influences thermal performance, with engineering thermoplastics such as polycarbonate, polypropylene, and certain PET grades demonstrating substantially greater heat resistance than commodity polymers like PLA or ABS.

5.4 Interpretation of Mechanical-Fire Relationships

The absence of strong correlations between mechanical and fire-related variables suggests that these properties are not a simple trade-off across thermoplastic materials. Instead, multiple underlying factors likely influence both property groups simultaneously. Differences in polymer backbone chemistry can affect thermal stability and mechanical toughness by altering chain rigidity and the glass transition temperature. Crystallinity and morphology also influence behavior, as semi-crystalline polymers can exhibit improved thermal resistance while maintaining varying levels of toughness depending on microstructural organization. In addition, the formulation of materials and the additives commonly used in commercial thermoplastics, such as flame retardants, impact modifiers, and reinforcing fillers, can significantly alter both mechanical performance and fire-related metrics. These factors show variability that can weaken simple pairwise statistical relationships between properties, helping explain why clear correlations were not observed across the dataset. These results highlight the importance of considering broader structural and formulation characteristics when interpreting statistical relationships within engineering materials datasets. These interpretations are based on observed statistical patterns and should not be interpreted as causal relationships.

5.5 Limitations of Individual Fire Metrics

The results also demonstrate the limitation of using UL-94 and LOI test results independently to describe material performance. Since these tests measure different aspects, interpreting the results separately can yield an incomplete picture.

5.6 Fire-Resistance Proxy Score (FRPS)

To address this issue, this study proposes a conceptual Fire-Resistance Proxy Score (FRPS). The FRPS combines several fire-related indicators into a single screening-level metric. Each variable was normalized to a 0–1 scale before aggregation to ensure comparable weighting across different measurement units.

Example structure:

The Fire-Resistance Proxy Score (FRPS) can be defined as a normalized composite index:

$$FRPS = w_1(\text{UL-94 score}) + w_2(\text{LOI normalized}) + w_3(\text{HDT normalized}) \quad (1)$$

where w_1, w_2, and w_3 represent weighting factors assigned to each variable. All variables were normalized to a 0–1 scale before aggregation to ensure comparability across measurement units.

In this study, equal weighting was assumed for all variables due to the absence of a validated weighting framework for comparative fire performance.

This composite approach allows multiple fire-related indicators to be interpreted within a single comparative framework, potentially simplifying early-stage screening of thermoplastic materials.

In this study, FRPS was computed as a normalized composite index combining LOI values, numerical UL-94 classification scores, and heat deflection temperature measurements.

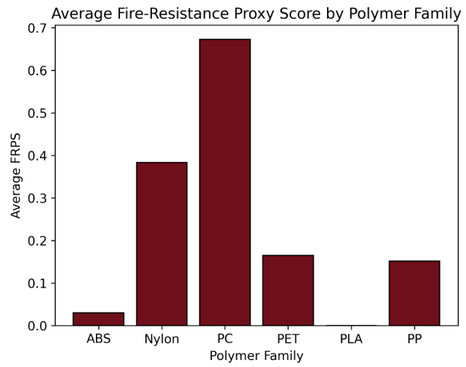

Figure 6. Average Fire Resistance Proxy Score (FRPS) calculated for each polymer family using LOI, UL 94 classification, and HDT.

UL-94 provides information about ignition and self-extinguishing behavior, LOI represents the oxygen threshold for combustion, and HDT represents thermal stability under load. Combining these variables produces a more comprehensive representation of fire-related performance (Figure 6).

Because FRPS relies on simplified data, it should be interpreted as a comparative ranking tool rather than a predictive fire model.

5.7 Implications for Additive Manufacturing

Many of the thermoplastics included in this dataset are widely used in additive manufacturing, particularly fused deposition modeling (FDM). As additive manufacturing moves from rapid prototyping to the creation of functional end-use parts, it becomes even more important to understand the interrelationships among material properties. Some of the commonly used thermoplastics in 3D printing include polylactic acid, polyethylene terephthalate glycol-modified, acrylonitrile butadiene styrene, and polycarbonate.

The selection of materials for additive manufacturing processes is often based on information from property tables or experiential knowledge. As fire properties may play an even more significant role in the creation of functional printed parts, a screening tool like FRPS could help engineers evaluate materials more systematically. These results suggest that statistical screening tools, such as FRPS, complement traditional materials databases by highlighting structural performance trade-offs across commonly used additive manufacturing polymers. However, these implications should be interpreted within the limitations of datasheet-derived inputs and simplified fire-performance metrics.

6. LIMITATIONS AND SOURCES OF BIAS

Several limitations affect the interpretation of this analysis. The dataset is relatively small (N = 18 materials), limiting statistical power and the ability to detect subtle relationships between variables. As a result, statistical findings should be interpreted as exploratory rather than definitive.

A key limitation comes from the use of manufacturer datasheets and publicly reported materials data. These sources may introduce systemic bias, as material properties are often reported under controlled laboratory conditions that may not reflect real-world performance. In addition, manufacturers may selectively report properties that highlight favorable characteristics of their materials, thus influencing the distribution of values in the dataset.

Variability in testing methods and reporting standards further affects data comparability. Differences in specimen preparation, test conditions, and measurement protocols across sources introduce noise that can weaken observed statistical relationships. This is particularly relevant for properties such as impact resistance and HDT, which are sensitive to experimental conditions.

The use of derived or transformed variables also introduces limitations. For example, UL-94 classifications were converted into numerical scores for analysis, and the Fire-Resistance Proxy Score (FRPS) aggregates multiple normalized variables into a single index. While these transformations enable statistical comparison, they simplify complex material behaviors and may obscure underlying mechanisms.

No financial or commercial conflicts of interest are present in this study. All data were obtained from publicly available sources and analyzed independently. However, the inherent bias in manufacturer-reported data remains an important consideration when interpreting results.

Future work can address limitations by incorporating larger datasets, standardized experimental measurements, and additional fire-performance metrics such as cone calorimetry. Expanding the dataset and improving consistency across measurements would enable more robust statistical inference and strengthen the validity of observed relationships.

7. CONCLUSION

This study applied statistical methods to evaluate relationships between mechanical properties and fire-related metrics across thermoplastics. Results indicate weak correlations between individual mechanical and fire variables but clearer differences across polymer families.

These findings suggest that polymer structure may play a larger role in determining performance tradeoffs than simple relationships between variables.

The conceptual Fire-Resistance Proxy Score introduced in this paper provides a potential framework for combining multiple fire-related metrics into a single comparative indicator. Approaches that integrate multiple performance metrics may ultimately provide more practical guidance for engineers selecting materials in safety-sensitive applications. While not a replacement for detailed fire testing, such a metric may support early-stage engineering material selection and comparative analysis. More broadly, this study illustrates how statistical analysis can complement traditional materials science approaches by revealing structure–property patterns within heterogeneous engineering datasets. However, overall, the findings should be interpreted as exploratory and provide a foundation for further investigation rather than definitive conclusions. Future work incorporating controlled experimental datasets would be necessary to validate these trends under standardized conditions.

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“Denglish”: Digital Linguistic Diffusion of English into German by Nika Karpelevitch

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ABSTRACT

Social media has emerged as a powerful catalyst for linguistic evolution. From “buzzwords” to trending songs, highly engaging short-form video content is shaping our vocabularies, jokes, and earworms. Dominating popular culture on these platforms, the English language is an “influencer” itself, inspiring the adoption of English words worldwide. In exploring this digital linguistic diffusion, my research spotlights the German-speaking experience. Specifically, which linguistic trends, creator demographics, and content styles motivate increased verbal anglicism use among German-speaking Instagram content creators? First, I examined the use of anglicisms in 525 Instagram Story posts across six creators, tracking three key anglicisms. Next, I transcribed 114 of their Instagram Reel posts using Turboscribe.ai and calculated anglicism ratios per Reel. I also used Google Apps Script to quantify anglicism frequencies. My findings link higher average anglicism use to Gen-Z creators (4.36%) compared to Millennials (2.82%). My results also indicate strategically increased anglicism use in promotional content (4%) compared to health and wellness content (3.25%) intended to boost user engagement. The prevalence of English in the digital lexica of foreign public personalities reflects the global importance of American cultural capital accumulation with social and economic consequences beyond the scroll.

INTRODUCTION

Living languages are constantly changing and evolving. Language contact, a form of external language change, has emerged as a major driving force in language evolution, resulting in the lexical, morphological, and phonological transmissions enriching our world languages today (Ottenheimer & Pine, 2019). In an increasingly globalized world, in which different countries and cultures have come into closer contact than ever before, language exchange has substantially accelerated. Additionally, English has emerged as an “international language,” expanding its linguistic reach on a global scale (Ottenheimer & Pine, 2019).

Language change can spark fear, resentment, and opposition, and in Germany specifically, growing English influence has given rise to the language purification movement, known in German as Sprachpurismus (Hadzimuratovic, 2023). The Verein Deutsche Sprache (VDS), a German language purification organization, was founded in 1997 to “preserve” the German language against the growing influence of English in Germany following the second world war (Truslove, 2024). This study utilizes the latest (2023) edition of the VDS Anglizismenindex, a list of

Anglicisms and their German replacements, to cross-reference anglicisms uncovered in collected data. “Anglicism” is defined by the Cambridge English Dictionary as “an English word or phrase that is used in another language” (Cambridge Dictionary, 2025).

According to Cantarini (2023), English use among German speakers in Germany has experienced accelerated growth since the nineties. In addition, the internet has become a significant catalyst for linguistic diffusion and language change as a host for dynamic interactions between users (Hamilton et al., 2025 as cited in Isnarini et al., 2025). One of the leading social media platforms facilitating these user exchanges is Instagram; With 3 billion active users globally as of February 2025, Instagram is the world' s second-most popular social network globally (Dixon, 2025). Of the 3 billion global users, 47.2 million are located in Germany, making Germany the country with the ninth-largest Instagram audience size (Dixon, 2025; Koch, 2025). In Germany, Instagram surpassed Facebook in popularity for the first time in 2024, indicating the app’s rise in popularity in the country (Nielsen, 2024 as cited in Koch, 2025). Additionally, Millennials and members of Generation Z dominate the platform, with over 31% of Instagram users falling between the ages of 25 and 34 (Dixon, 2025). As of January 2025, 79% of global marketers advertised their businesses though Instagram, demonstrating its important role as a marketing platform globally (Dixon, 2025). Of the many posting features offered by Instagram, this study will narrow its focus to examine audio-visual content featuring the spoken language of creators. Stage I of data collection examines Story posts, and stage II of data collection examines Reel posts. Story posts are temporary photo and video posts featuring everyday moments that are available to view for only 24 hours (Instagram, 2024). Reels are permanent short-video posts up to three minutes in length (Instagram, 2025).

II. LITERATURE REVIEW

Cantarini (2023) provides an overview of recent additions to the German lexicon, known as neologisms, focusing specifically on anglicisms, within the framework of the digital Neologismenwörterbuch in the Online-Wortschatz-Informationssystem Deutsch (OWID), an online database featuring 2,100 new words, phrases, and meanings that have entered the German language since the year 1991. As part of my study, I made use of the Neologismenwörterbuch to cross-reference anglicisms collected in my data. Referencing the categorizations of Busse (2001), The types of lexical borrowings defined and discussed include: Direct Borrowings, Substitutions and Loan Translations, Partial Substitutions, Pseudo-Anglicisms, Reborrowings, and Internationalisms/Eurolatinisms. The focus of my study is on Direct Borrowings, which are the most frequent form of lexical borrowings, and which vary in degree of integration. Cantarini (2023) pulls from Busse (2001) in discussion of the degrees of distribution and acceptance of lexical borrowings. The lowest degree of distribution and acceptance is defined as Category 0, in which mutually intelligible English words are applied to uniquely foreign situations that are difficult to translate into German, only appearing in highly specific contexts (e.g. “-gate,” after Nixon’s “Watergate”). Categories 1 and 2 include expressions limited in usage to certain speaking communities, styles, and registers, such as oral vs written language, and youth language, and their English origins remain largely recognizable (e.g. “Jeans”). Conversely, the English origins of words in category 3 are not as easily recognizable (e.g. “Boot,” “Sport”). Lastly, words in category 4 have been semantically transferred from

English, but are formally identical to their German equivalents (e.g. Maus for "computer mouse"). Overall, the work of Cantarini (2023) serves as a helpful linguistic roadmap for the study of neologisms in the German language.

Hadzimuratovic (2023) defines "anglicism" as a word that is wholly or partially derived from English, and refers to words specifically derived from varieties of American English as "Americanisms." Hadzimuratovic (2023) also mentions the distinction between "evident/external" and "latent/internal" borrowings. According to this distinction, Direct Borrowings, or direkte Entlehnungen can be further categorized as being either "foreign words," known in German as Fremdwörter, which retain foreign pronunciation, spelling, and grammar, or "loanwords," known in German as Lehnwörter, which have been modified to integrate into the German language. The study of Hadzimuratovic (2023) focused principally on public attitudes towards anglicism use among German speakers, and identified participant surveys as optimal methods for examining acceptability. The survey included participant background information questions, and asked participants to analyze texts, from which their rejection or acceptance of anglicisms were evaluated. The study found that 90% of the 300 participants surveyed predicted the increase of English expressions in media, and that acceptance of anglicisms among participants was greatest in regards to entertainment and technology. However, fears persisted among participants surrounding German language loss with the growth of English influence. The study by Hadzimuratovic (2023) provided additional classifications and descriptions of anglicisms in the German language which it used to gauge their acceptability among German speakers.

Sourcing data from Instagram, Schwarz (2024) examined written codeswitching between the English and German languages in post captions. The research analyzed the captions of four German influencers over a 10-year period to identify potential linguistic trends. The study found that the average rate of sentences including instances of codeswitching had a mean proportion of 10.6% across all participants. The study also identified a 222% increase in the average percentage of codeswitching from the year 2014 to the year 2024, from 10.6% to 34.1%. In addition to quantitative analysis, the study also conducted qualitative analysis of select captions, discussing codeswitching varieties. The study is limited in scope due to its small dataset, but nonetheless provides insight into trends in English use among German content creators on Instagram.

In a comparative sociolinguistic study examining anglicism use and public attitudes across several German-speaking populations, Truslove (2024) identified that younger speakers, and especially "digital natives" used more anglicisms than older speakers. Additionally, the researcher noted the overrepresentation of written and media sources in previous research conducted on anglicisms to explain their choice to investigate the "ordinary" German speaker. The study also dissected the differential borrowing of word classes, finding that nouns constituted a majority of all anglicisms, at 80%, followed by adjectives, at 10%, verbs at 3–4%, and adverbs at a scant 1%. In qualitative analysis, the researcher attributed the preferential use of many anglicisms, such as "Fan," "Slang," and "Basics" to their shorter length and catchiness as compared with their German equivalents, Anhänger, Umgangssprache, and Basiswissen, respectively. This conclusion was also confirmed by interviewees, who claimed that the English words are "catchier," or "more concise." The study also determined the higher frequency of anglicism use in written language as opposed to spoken language, with proportions of anglicisms at 3.02% and 0.87%, respectively, in the Tokens analysis, and 4.83% and 1.96%, respectively, in the Types analysis. This study also discovered that public attitudes towards anglicism use were largely negative, especially among older participants. This study provides a good look into anglicism use in Germany, investigating anglicism type, frequency of use, and public opinion.

III. PURPOSE AND HYPOTHESES

The purpose of this study is to investigate the diffusion of English lexical borrowings, and their verbal applications among German content creators on the social media platform Instagram with the goal of contributing to greater understanding of the role of social media in perpetuating language change. The hypotheses for this study are as follows: The "Generation Hypothesis" stated that members of Generation Z use more anglicisms in their content than Millennials; The "Audience Size Hypothesis" stated that content creators with larger follower counts use more anglicisms than those with smaller follower counts; The "Genre Hypothesis" stated that promotional content uses more anglicisms than health and wellness content; The "Time Hypothesis" stated that a net increase in Anglicism use occurred across the time period studied (October of 2023 to October of 2025).

IV. METHOD

For this study, I selected six German, female Instagram content creators to investigate the German-language content of. The scope of this study has been narrowed to accommodate time and resource constraints. My participant selection criteria is as follows: The participants must be born, raised, and currently living and working in Germany, must be ethnically German, and must be female. Additional criteria include regular posting on active accounts, and the regular use of spoken German in posts. I also selected by age and follower count, to determine the potential impacts of these variables on language. Three of my participants are classified as members of the Millennial generation, and the other three are members of Generation Z. Following the influencer classifications outlined by (Haenlein & Libai, 2017 as cited in Conde & Casais, 2023), at the time of my study, two of my participants were classified as "Mega influencers," with Instagram follower counts exceeding 1M. Two participants are classified as "Macro influencers," with Instagram follower counts falling between 100K and 1M, and two participants are "Micro influencers," with Instagram follower counts falling below 100K.

To maintain anonymity, I assigned pseudonyms to my participants.

Table 1. Listed by pseudonym, follower count, and age.

Pseudonym	Follower Count (approx.)	Age
Influencer M	2,500,000	33
Influencer E	1,300,000	25
Influencer K	514,000	28
Influencer F	429,000	24
Influencer G	95,000	39
Influencer J	31,500	25

A. Apparatus and Materials

For this study, I sourced my data from publicly available German-language content on the social media platform Instagram. I used Turboscribe.ai to produce German-language transcriptions of selected Reel posts. I used the following German-language reference materials: Neologismenwörterbuch (OWID), Anglizismen-Index (VDS), and the

digital Langenscheidt dictionary. Additionally, with assistance from Google's Gemini, I used code in Apps Script to automate word counts as a secondary method in my data analysis.

B. Procedure

First, participants were categorized by age group and audience size. The participants aged 24–25 (Influencers E, F, J) were grouped as Generation Z, and the three aged 28–39 (Influencers M, K, G) were grouped as Millennials. Influencers M and E were grouped as "Mega influencers," Influencers K and F were grouped as "Macro influencers," and Influencers G and J were grouped as "Micro influencers."

The Independent Variables of this study were: 1) Generation (Millennial or Generation Z), 2) Content type (Promotional or Health/Wellness), 3) Audience size ("Mega," "Macro," or "Micro"), and 4) Time (the two years spanning October 2023 and October 2025). The Dependent Variable of this study was English Words as a percentage of total words spoken. To narrow the scope of the study, I selected for: 1) Gender of participants (female), 2) Ethnicity of participants (German), 3) Location of participants (Germany).

1. Stage I — Upon selecting and researching the participants for this study, I watched and collected verbal data from each participant's daily Story posts in the 20 days spanning from October 9 to October 29, 2025. Throughout this period, I manually tallied the English words spoken by participants in their Story posts. I recorded and organized my collected data in a Google Sheet by creator, audience size ("Mega," "Macro," or "Micro"), by length, and by content type. My original content type categories included: Activism, Beauty, Brand Deal, Cleaning, Event, Fashion, Food/Cooking, Health, Life Update, Mental Health, Random, and Travel. I did not record repeats of the same words found within the same story posts in this stage of data collection. My main aim in this stage of the study was to identify the current trends in anglicism use among participants.

2. Stage II — The second stage of my data collection involved counting English words used in participants' Reel posts as a percentage of total words spoken. This consisted of selecting and transcribing a total of 114 Reel posts across all participants. For each month of the two year-period studied, I selected one Reel per participant to transcribe and analyze. I selected the Reels with the highest view count in their respective month, and adhered to the following sampling criteria and considerations. If two eligible Reels within a given month shared the highest view count, the Reel with the greater number of Likes would be selected. In order to be selected, a Reel must have consisted principally of the spoken language of its creator. Reels using creator voiceovers rather than live speech were also eligible for selection. In this stage of the study, repeated English word use was accounted for in English word counts.

The following is a list of words pertaining to Instagram and its features and their German-language app version equivalents that I counted as English due to naming differences: "Post" (Beitrag), "DM" (Direktnachrichten), "Like" (Gefällt), and "Caption" (Bildunterschrift). In contrast, the following is a list of other words pertaining to Instagram and its features whose names are consistent across both the English-language and German-language versions of the platform, and were thus not counted as being English due to the lack of formally recognized German-language equivalents: "Reel," "Story," and "Follower."

Additionally, I excluded the names of brands, specific products, and specific product features, as well as English language song lyrics from English word counts. I also did not include Reels featuring conversations between participants and others in my data collection to minimize external influence from outside my pool of participants. In Google Sheets, I categorized the selected Reels by creator, date, and content type, which I narrowed down to consist of two broader categories: Promotional content and Health/Wellness content. Finding that a sizable portion of my collected content was either paid advertising, or promotional in nature, I decided to consolidate my original categories of Beauty, Brand Deal, and Fashion into the overarching category of Promotional. Accordingly, I generalized the other content that I collected, which largely consisted of comedy and discussions of mental, physical, and emotional health under Health/Wellness.

Next, I manually reviewed each selected Reel to ensure that all criteria were met, and produced transcriptions using Turboscribe.ai, where I utilized the highest-accuracy "Whale" transcription settings. I automated the calculation of total word count for each transcript in Google Sheets, which was not case-sensitive, and counted hyphenated words as single words. I manually counted the number of English words from the transcripts, adhering to the previously listed criteria, and automated the calculation of the percentage of English words for each individual video. I also kept an automated count of three key Anglicisms identified in the first stage of my research: "crazy," "cool," and "checken" ("checken" meaning "to understand' or "to get" something). I also kept an automated count of these words' German-language equivalents, as listed in the Langenscheidt Dictionary (n.d.), and Anglizismenindex (2023), in parallel: verrückt and toll for "crazy," geil for "cool," and begreifen, and verstehen for "checken."

To categorize the frequency of English words used across all collected data, an alternative data analysis method involved using Apps Script code to create a complete list of all words from the transcripts, ordered from highest to lowest frequency of occurrence, and to detect, count, and list all English words by frequency of occurrence. I manually reviewed the English list, from which I deducted ineligible words according to my own counting criteria, as well as any words that weren't the main parts of speech (e.g. "a," "an,"), and any errors. According to this quantifying system, a total of 649 English words were counted across all Reels, as compared to my manually counted 827 words. These discrepancies can be attributed to both human and machine error, and differences between my selection criteria and that of the automated quantifying system; Nonetheless, use of both methods provided a more comprehensive overview of my data.

V. Results

This study was a quantitative and qualitative examination of the prevalence of English words in the spoken German of female German content creators used in their

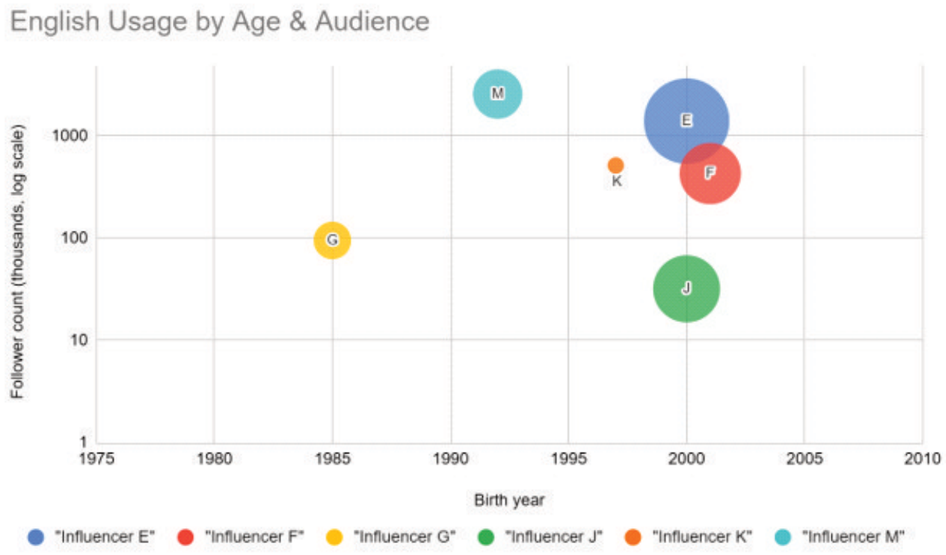

Figure 1.

Instagram Story and Reel posts. My "Generation Hypothesis" stated that anglicisms constitute a greater percentage of the spoken language of participants belonging to Generation Z as compared to participants belonging to the Millennial Generation. My "Genre Hypothesis" stated that Reels belonging to the Promotional content type category demonstrate a greater percentage of anglicisms than Reels in the Health/Wellness category. My "Audience Size Hypothesis" stated that creators with larger follower counts use a greater percentage of anglicisms in their content than creators with smaller follower counts. My "Time Hypothesis" stated that in the span of two years, from October of 2023 to October of 2025, a net increase in anglicism percentage among content creators has occurred.

Overall, the highest percentage of English recorded in any given Reel was a staggering 22%, and the lowest was 0% in a total of seven Reels. The total weighted mean of English percentage across all 114 collected Reels was 3.5%.

For the quantitative leg of my data analysis, a positive correlation between creator birth year and English percentage was identified. As seen in figure 1, which represents the creator birth year (x-axis) by follower count in thousands, log scale (y-axis), all three participants belonging to Generation Z showed higher weighted average percentages of English than their Millennial counterparts, regardless of audience size. The greatest English percentage was attributed to "Mega influencer" "Influencer E," at 5.25%. Conversely, her Millennial "Mega influencer" counterpart, "Influencer M," whose audience was greater than "Influencer E's" by 1.1 million followers, showed just 3.18% English, suggesting that a creator's generation was potentially a more significant factor on their English use than audience size was. Second to "Influencer E," Generation Z "Micro influencer" "Influencer J" used 4.10% English, 1.35% greater than Millennial "Micro

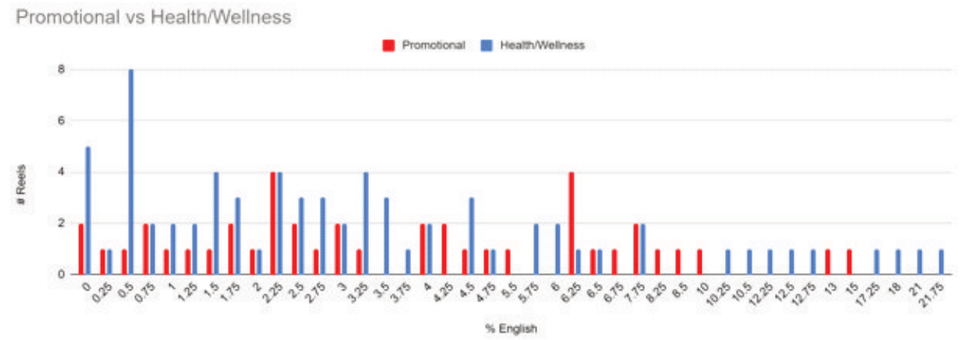

Figure 2.

influencer" "Influencer G," despite having 63,000 fewer followers. This trend is continued with the "Macro influencers": Generation Z "Influencer F" and Millennial "Influencer K" had English percentages of 3.76% and 2.47%, respectively, despite a difference of 85,000 followers.

Continuing with quantitative analysis, there was sufficient data to support the "Genre Hypothesis," that the Promotional content type category demonstrates a higher average English percentage than the Health/Wellness category, at 4% and 3.25%, respectively. As seen in figure 2, which measures average English percentage (x-axis) by number of Reels (y-axis), across the two categories, Promotional Reels generally exceeded Health/Wellness Reels in average English percentage.

I also investigated the countries of origin of the companies and brands advertised by participants in Promotional Reels to evaluate their potential impact on English word usage. I found that 20 out of the total 42 Reels collected in the Promotional category promoted German companies, with the remaining 22 Reels promoting non-German companies. Calculating the weighted means of the English word percentages of both subcategories, I found that the weighted means of the English word percentage of German-company Promotional Reels was 3.54%, while that of Non-German Advertisement Reels was 4.74%. Although the possibility of Promotional Reels being wholly or partially scripted by advertisers could not be entirely ruled out, a significant disparity in English usage was identified between German and non-German Promotional content.

For the qualitative leg of my data analysis, I observed noteworthy trends in English word usage across both stages of data collection. Throughout stage I of data collection, during which I analyzed the Story posts of participants, I observed the prevalence of several English words that I chose to track in stage II of data collection. Three of the highest frequency words identified were "crazy," "cool," and "checken." The prevalence of the word "crazy" is supported by the nomination and victory of the phrase "das crazy" (literally: "that crazy") in Langenscheidt's 2025 Jugendwort des Jahres "Youth Word of the Year" annual contest, voted for by German youth (Cords, 2025). I observed the frequent use of both "das crazy" and simply "crazy," which was used as a descriptor, usually with a positive connotation, to express disbelief and amazement. A typical example of the use of "crazy" in a German sentence is: Das Event war so crazy! translating to "The event was so crazy!" I found "crazy" to be used at least once in 26

Story posts across all participants. Despite the word's immense popularity observed in Story posts, only one Reel post featured the word "crazy" out of all 114 Reels collected. Comparing "crazy" to its German equivalents, both verrückt and toll were found in four Reels each.

The second English word I tracked was "cool," a direct borrowing of the English slang word that holds a similar meaning in German: "extraordinary, striking, impressive" (Neologismenwörterbuch, 2025). An example of a German sentence using "cool" would be: Ich finde dieses Outfit richtig cool translating to "I find this outfit really cool." The word "cool" was used at least once in a total of 39 Story posts across all participants. Comparatively, "cool" was identified in 12 Reels. A German equivalent of "cool," geil, was identified in eight Reels.

"Checken," a verb derived from the English "to check," and meaning "to understand," or "to get," according to Neologismenwörterbuch (2025), was the third and final English word I tracked. The phrase "Checkst du?" which literally translates to "Do you check?" and means "Do you understand?" was a close runner-up to "das crazy" in the 2025 Langenscheidt Jugendwort des Jahres contest, losing narrowly to the latter (Cords, 2025). An example of a German sentence using "checken" is: Checkst du, was ich meine? translating to "Do you get what I mean?" I found "checken" to be used at least once in 18 Story posts across all participants. "Checken" was found in 12 Reels. Begreifen, a German equivalent to "checken," had zero usage in Reel posts, and verstehen was only used in two Reels.

VI. Discussion

As revealed in my study, English words are a consistent feature of the lexicons of female German content creators in their Instagram content. Lacking the testimonies of the participants themselves, it cannot be stated for certain their intentions in choosing to use certain English words over German words, however, it can be inferred that, as revealed in the study by Truslove (2024), content creators might tend to gravitate towards the catchiness and short length of English words as opposed to German words. In the context of my study, this may be best demonstrated by "checken," when comparing the sentence Checkst du? Meaning "Do you get it?" to its longer German equivalents: Begreifst du? Or Verstehst du?

Regarding trends in the rising frequency of English use on Instagram over time, my findings, which were inconclusive, contrasted with those of Schwarz (2024), who identified a significant increase in codeswitching between English and German in Instagram captions over a 10-year period. This inconsistency can be attributed to differences in the lengths of time examined in our respective studies, with mine focusing on just two years' worth of data compared to Schwarz (2024), who examined 10 years' worth. Another important factor to consider is the differences in anglicism frequency across text types (written vs spoken language), as identified by Truslove (2024), who determined that anglicisms are more prevalent in written German as opposed to spoken German.

Further evaluating my findings regarding the three English words I tracked throughout the study, "crazy," "cool," and "checken," I predict that their differential usage over time might be attributed to differences in word class and longevity of linguistic trends. For instance, despite its near absence from Reels, "crazy" was used exhaustively in the Story posts of the participants throughout October 2025, suggesting that it may have only emerged as a widespread linguistic trend beginning then, and explaining its absence

from older Reel posts from the two-year time period studied.

Comparatively, the word "cool" was much more widely used among participants, with several explanations to explain this discrepancy. One possible explanation of the difference in the two words' usage can be attributed to the difficulty of their pronunciations. Neither of the words were adapted to fit German pronunciation by my participants, however, it can be inferred that the pronunciation of the English "r" tends to be more difficult for German speakers to pronounce than the word "cool," which has a phonetically similar German equivalent, kühl. Alternatively, it can be reasoned that the word "cool" is simply more universally applicable to a greater number of situations than "crazy" is, thus warranting its greater use.

Unlike the words "crazy" and "cool," the word "checken" is not an adjective, but rather a verb. Drawing from Truslove (2024), word class has been found to influence the frequency of anglicism use, with adjectives generally constituting a greater percentage of anglicisms used than verbs. This important distinction between "checken" and the other words tracked in my study may explain the word's slightly lower frequency of use in Story posts as compared to "crazy" and "checken."

Some additional repeatedly used English words that I identified throughout the course of this study are examples of promotional terminology, observed in content advertising both German and non-German companies: "favorite," "gamechanger," and "outfit." According to the lexical borrowing categorization system explained by Busse (2001) and Cantarini (2023), I placed these three words into Categories 1 or 2 of distribution and acceptance due to their recognizable English origins in pronunciation and their usage being nearly exclusive to advertising.

The word "favorite," and its variations, including "favorites," and "favs," were used frequently, but did not entirely replace the use of the German equivalent lieblings. The words "favorite," "favorites," and "favs" showed widespread use and significant longevity across all participants, a trend that can potentially be attributed to direct linguistic influence from the content of English-speaking creators.

Throughout my data collection, I found that the word "outfit," or "fit," had almost entirely replaced the German Kleidung, again, demonstrating the potential influence of English-speaking Instagram on participant word choice.

Some noteworthy frequently-used English words pertaining to Health/Wellness were: "run" and "energy." From my collected data, I found that the English noun "run" often replaced its German equivalent Lauf, whereas the verb form most often remained the German laufen. The use of the English noun but the German verb demonstrates the greater prevalence of nouns as compared to verbs in anglicism use, as outlined by Truslove (2024). Additionally, I observed the periodic use of the word "energy," in the English pronunciation to replace the very similar German energie, particularly in discussions of physical and mental energy. I found the use of this word to be especially intriguing, as it may indicate that the English word "energy" is regarded as having wider and more abstract applications than the German equivalent.

Overall, my "Generation Hypothesis" was not refuted by the results of this study, with data pointing towards a potential positive correlation between birth year and English word use, and with Generation Z participants showing higher average English percentage than Millennial participants. My "Genre Hypothesis" was similarly supported by my findings, showing greater overall English use in Promotional content as opposed to Health/Wellness content. I found that net English use

remained relatively constant, with only slight fluctuations, in the studied time period spanning October of 2023 and October of 2025. There was not sufficient data uncovered to confirm my "Audience Size" hypothesis, that a greater number of followers corresponds to greater English use.

This study was limited in scope and scale due to time and resource constraints, resulting in limitations to the sample size, amount of content, and length of the time span studied. There also remains potential for transcription inaccuracies and human and machine counting errors.

It is also worth mentioning that I, as the researcher, am not a native German speaker, and that despite my best efforts to accurately translate and cross-check collected German-language data, there remains potential for the unintentional influences of implicit English-language biases and non-native German language proficiency on my study's findings.

The findings of this study raise new questions regarding the influence of English on other digital German-speaking populations, probing consideration beyond the bounds of this study to include other social media apps, age groups, genders, and ethnicities in future research. Despite the small scale of this study, I hope for its findings to contribute to a greater recognition, understanding, and acceptance of digital linguistic diffusion and change, and for it to serve as a springboard for future research. Ultimately, language change is an inevitable phenomenon, and it will only continue to accelerate as the world becomes increasingly interconnected through the internet. Showing empathy for fellow language users while building our understanding of the internet's linguistic roles is an important and productive first step to addressing language change.

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The Neurological Advantages of Multilingualism

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ABSTRACT

Multilingualism is growing worldwide and offers significant cognitive, social, and neurological benefits. This review examines the complex parts of the brain, behavior, and social contexts of a multilingual individual, specifically in neurobiology, education, health, and the workplace. It is a cognitive exercise that modifies grey matter (GM) thickness in goal maintenance and white matter that controls ventral pathways. Different structural differences support code-switching, cognitive inhibition, and creative problem-solving skills across age groups. In educational settings, having high proficiency in the second language will enhance mathematical performance, and in work settings, it will bring socio-economic advantages. Constant practicing of languages can delay clinical neurodegenerative diseases like Alzheimer's up to four years. Despite the advantages, multilinguals still face discrimination in schools or at work from the stigma that, because others cannot understand the language, it means they are talking inappropriately. This paper argues that while multilingualism is a language skill, it is also advantageous in social and neurological contexts.

I. INTRODUCTION

Bilingualism is common in today's society, where it can be used for both professional and personal purposes (González-Martín, Berd-Gómez, Saura-Montesinos, Biel-Maeso, & Abrahamse, 2024). In America's society today, up to 60 million people, or 1 in 5 people, can speak more than one language, with Spanish being the most common, followed by Asian languages (Gándara, 2015). The growing multilingual population is prompting researchers better to understand the cognitive and social aspects of this skill. People with multilingual skills show cognitive benefits in handling task demands, attention switching, discarding irrelevant information, and code-switching. The benefits of bilingualism vary by a person's age and how well they speak their second language. For example, young bilinguals experience the flanker effect, a delay in reaction time caused by the brain struggling to ignore distractions. In contrast, highly fluent older adults do not experience this effect (Dong & Li, 2015). Educational performance is also based on a multilingual person's proficiency; if they are less proficient, they will have less of a "parallel" skill and have a harder time doing well in school, and vice versa. Having the skills to do task switching is important, based on second-language exposure from a young age and how much they use their language in daily life. Remarkably, the type of language used depends on task-switching skills: Chinese English speakers switch less while speaking, whereas Spanish English speakers switch more (Dong et al., 2015).

Being multilingual can help people develop workplace skills and, when they are sick, delay the onset of diseases like Alzheimer's. Despite these advantages, there is still discrimination against monolinguals and bilinguals, especially in educational and work settings. In education, parents are worried that confusing their children with the different languages they are learning may steer them away from learning a second language. In the workplace, bosses and coworkers often dislike hearing another language besides English because they worry their coworkers are speaking poorly of them, even if the conversation is harmless and completely unrelated. Despite the social and academic barriers multilingual individuals may face, the substantial cognitive benefits in education, task-switching, and the delay of neurodegenerative diseases demonstrate that multilingualism is an essential and highly valuable skill.

II. THE MULTILINGUAL BRAIN

A multilingual speaker must remain committed to speaking a language in an interactive context, which is very difficult for most. Many multilingual individuals use their language at home with friends and family, or learn new vocabulary and phrases at social events, such as school or work. Having the demand on the brain, maintaining task goals, with high proficiency in many languages, and often in an advanced linguistic situation, trains it to control processes and interference, structuring the brain differently than in a multilingual individual, has decreased gray matter (GM) thickness in the brain, specifically in the region that supports goal maintenance and memory retrieval (Midrigan-Ciochina, Vodacek, Balabhadra, Corina, 2024). Gray matter is composed of cell tissue in the area of the neural tissues, appearing like a pinkish-gray butterfly shape (Freberg, 2023), surrounding the outer parts of the brain.

To better understand the structures, the relationship between proficient bilinguals and GM is characterized by an inverted U-shape, meaning that when a bilingual person is learning a language, their anterior cingulate cortex and inferior parietal cortex increase. Bilingual people rely less on their anterior cortical regions and more on their subcortical and posterior regions for language processing, making it more efficient (Midrigan-Ciochina et al., 2024). Anterior regions are towards the front of something, while posterior regions are towards the rear (Freberg, 2023). Subcortical regions of a bilingual brain are different from those of a monolingual brain, specifically the putamen, thalamus, pallidum, and caudate nucleus (Midrigan-Ciochina et al., 2024).

The structural differences in these regions are not the same for every multilingual individual; the brain regions vary depending on how long a person has been immersed in their language. For example, an individual who has been immersed in their second language for 3.5 years showed that one part of their right caudate nucleus was larger, while the other was smaller, and that both the thalamus and putamen were smaller than those of a monolingual person. A person who has been immersed in their language for 7 years had an increase in GM surface. While the functions of the brain differ across individuals, there is no difference in the frontal lobe regions of the brain between monolingual and multilingual individuals (Midrigan-Ciochina et al., 2024).

In addition to changes in grey matter, changes in brain structures involving white matter help communicate along the dorsal and ventral pathways. Brain reconstruction in a multilingual's brain may lead to reduced functional activation and reduction of gray

and white matter morphology, resulting in pruning Midrigan-Ciochina et al., 2024). White matter is composed of myelinated axons in neural tissue, appearing white due to the myelin that covers most human axons (Freberg, 2023).

Structural changes can be seen in how white matter is distributed across the dorsal, ventral, and medial pathways involved in language processing and control. The medial pathway is associated with language control and is located towards the midline, also associated with the corpus callosum (Midrigan-Ciochina, Vodacek, Sewell & Corina, 2024). In the dorsal pathway, there are the superior longitudinal fasciculus (SLF) and arcuate fasciculus (AF), and in a multilingual brain, fiber cross-section (FC) is increased, but fiber density (FB) is decreased. In contrast to the dorsal pathway, the ventral region, however, focuses on language processing and communication, specifically sound-to-meaning mapping, language comprehension, and basic syntactic processing. In a multilingual brain, dorsal pathways exhibit a higher fiber cross-section (FC) but a lower fiber density (FB) (Midrigan-Ciochina et al., 2024).

III. THE ADVANTAGES OF MULTILINGUALISM

A. Cognitive Development

Learning a new language involves specific neural pathways. While students learn a new language, the ventral stream serves as the primary language pathway for second-language learning, as it connects to the MTG and the ventrolateral prefrontal cortex for processing sounds into meaning. The dorsal ways connect to the superior temporal gyrus and promoter areas for repetition (Yang & Li, 2019). Students show increased activation in anterior cortical regions, including the inferior parietal cortex (Midrigan-Ciochina et al., 2024), and in the parietal lobule (Yang et al., 2019).

The language proficiency of a bilingual person is essential not only for mathematical topics such as basic arithmetic, problem-solving, and algebra, but also for any other educational topics. If a person has low proficiency in their two languages, the results in mathematics will be worse than those of people who are proficient in their languages (González-Martín et al., 2024).

The frontal lobe is the primary region for the top performance in a bilingual's language use. Bilingual people are especially good at creativity and awareness, and they generally have a higher IQ, suggesting that, hypothetically, they should perform better than monolinguals in almost all subjects. Although not related to bilingualism, people with a high white-matter capacity tend to use better arithmetic strategies (González-Martín et al., 2024).

In tasks where accuracy is a factor, highly proficient bilinguals would show better results than monolinguals, but there are cases in which underperformance occurs when reaction time is implemented (González-Martín et al., 2024).

In a bilingual person's brain, there is frequent switching between languages, which can slow reaction times when translating a number like 2 into its word form, "two". From this, a disadvantage bilingual people face is that they may not perform well under exam pressure, especially when mapping numbers to words, leading to confusion. In tasks, monolinguals are better at responding to stimuli, while bilinguals are better at numerical tasks, such as analytical reasoning (González-Martín et al., 2024).

In nonverbal activities, bilinguals perform better than monolinguals because being fluent in a language can facilitate solving tasks, abstract thinking, and flexibility in many situations. Although bilinguals perform

better, not all will; for example, highly proficient bilinguals may be slower at solving a mathematical problem, especially if it is in their non-preferred language. In math word problems, if a student is questioned in their second language, their performance would likely decrease compared to their preferred language, their mother tongue (González-Martín et al., 2024).

Beyond neurological consequences, chronic stress can also influence bilingual children's learning environments, including academic outcomes. Schools that implement bilingual education allow students from multilingual backgrounds to be exposed to their most likely second language. However, bilingual education comes with disadvantages, as low-proficiency students in their second language struggle to perform well in class (González-Martín, 2024).

Bilingual schools are weak at implementing societal norms in social contexts, thereby creating a disadvantage for bilinguals during socialization. Depending on the student's motivation in school, their performance will also vary. Ironically, parents of multilingual students worry that their children may not have the appropriate social skills if they speak their native language; therefore, they avoid introducing the culture or language. Those children would not attend a bilingual school due to cultural exposure (Alonso & Duñabeitia, 2024).

Some families also worry about code switching, which steers them away from bilingual schooling and worry that doing so will undermine the fluency of the languages, making their kid look sloppy when speaking their multiple languages. However, in reality, bilinguals often code-switch when speaking. Naturally, some families will code-switch, speaking different languages at once, which actually has a positive impact. In code-switching, bilinguals have "modes," meaning they can switch between bilingual and monolingual modes (Wechem & Halbach, 2016). In different degrees, code switching can engage in proactive or reactive controls (Jiang, Ma, & Chen, 2024). The person can decide when they want to be monolingual, depending on the social interactions they are encountering (Wechem et al., 2016).

Code-switching can be categorized into distinct patterns: Insertion, alternation, and dense, and each serves a unique function. Insertion patterns are patterns in which a person takes a word or phrase from a language and places it in their second language, using the grammar of the first language. As for alternation code-switching, it occurs when a person switches between languages, leading to dense patterns and interwoven languages in a random order (Jiang et al., 2024).

Sociolinguistics, the status of language, is important, especially in places with large multilingual populations. In economic situations, when there are more multilingual speakers, the motivation for others to learn the language increases (Wechem et al., 2016).

An example of a successful bilingual integration comes from Spain. In 1996, the British Council's Bilingual Education, BEP, collaborated with the Spanish Ministry of Education and other Governments to implement a bilingual program in schools in the capital Madrid, accepting up to 40,000 students. Parents enrolled their children in the program primarily to maintain their bilingual skills, as it is socially and culturally beneficial (Alonso et al., 2024).

The results demonstrated great success: by the fifth to sixth year, BEP Students learned English vocabulary and grammar structures quickly and were able to follow teachers' instructions easily, even though they were not very proficient. Later in 2009, students who attended BEP took an examination called IGCSE, which is purely an English test. After

the results were released, 100% of students who took the test passed, demonstrating their high level of English proficiency (Wechem et al., 2016).

Similarly, other European countries prioritize multilingualism for cultural and social reasons. Italy, for instance, found that if Italian students were able to learn French in schools, they would be able to learn about their diverse background, as French is spoken in the Valle d'Aosta region. Doing this will allow students to better integrate into society (Cheng & Hao, 2025). In the program, students who are exposed to code-switching at home perform better at school, suggesting that their parents often switch between languages (Alonso et al., 2024). This proves that multilingual environments not only shape cultural identities and cognitive systems in learning.

1. Creativity — These cognitive systems are closely related to creativity, which is the ability to produce a unique idea through divergent and convergent thinking. Divergent thinking involves generating answers from fluency and flexibility, while convergent thinking uses knowledgeable methods to analyze the best answers. Each person's creativity varies by language; for example, Korean-American students tend to be more creative, while Hebrew-Russian students can solve complex math problems creatively. In divergent and convergent thinking, Dutch-German bilinguals tend to show higher convergence than divergent thinking (Xia, An, & Guo, 2022).

Researchers found that bilingual people are more creative than monolinguals, with evidence that 9 of the 10 countries with the most Nobel Prize winners knew two or more languages, suggesting they can solve real-world problems creatively. Highly creative people versus low-creativity people have different semantic networks: highly creative people are more interconnected, while low-creativity people have shorter path lengths (Lange, Hopman, Zemla, & Austerweil, 2020).

Cognitive control is essential for creativity, as it helps regulate behavior to achieve goals. The more flexible, the easier it is to block conflicts and to learn from mistakes. As a person learns a new language, their cognitive control becomes more flexible in their convergent and divergent thinking. Related to convergent thinking, cognitive inhibition prevents the creation of "useless" connections, which supports creative problem-solving, and bilinguals tend to have more inhibition than monolinguals, especially in an educational setting (Xia et al., 2022). Bilingualism strengthens the brain's regulatory systems, exceeds more than just creativity and learning, but can also benefit in delaying long term brain diseases.

2. Delay Of Alzheimer's Disease — The strengthened skills are evident in the onset delays of memory loss, cognitive impairment, executive dysfunction, and loss of consciousness. Those are all symptoms of Alzheimer's disease (AD), one of the most prominent neurodegenerative disorders that causes structural and functional brain changes (Ávila-Villanueva, Dolado, Gómez-Ramírez, & Fernández-Blázquez, 2022). AD has been growing and will continue to grow in the population, especially among people aged 65 and older. Evidence suggests that bilinguals have a different function in their brains, causing those who get Alzheimer's disease will be diagnosed much later, on average, 4 years after a monolingual individual (Gold, 2015). Incurable Alzheimer's can appear at any time during a person's life, as it takes time to develop, and the brain structures also change in formation. As people age, they lose awareness of their surroundings, and sometimes this can be more than just natural forgetfulness (Ávila-Villanueva et al., 2022).

Delayed diagnosis is related to cognitive reserve, the relationship between brain pathological burdens and cognitive function that provides information on how the brain can cope with threats and maintain cognitive function. People with high cognitive reserve are more likely to experience brain decline than those with a usual reserve. Unlike monolinguals, Bilinguals have different cognitive reserves due to their environments during childhood. Although cognitive reserves differ between monolinguals and bilinguals, childhood influences their future risk of Alzheimer's. A Canadian bilingual individual's brain reserve is the same as a monolingual's; therefore, they will not benefit from their bilingual skills, as they most likely did not experience immigrant life with their parents or themselves. Bilingualism will also protect memory circuits affected in early Alzheimer's disease, thereby enhancing the neural system (Gold, 2015).

Two structures specifically indicate the origin of Alzheimer's disease: senile plaques and neurofibrillary tangles (Ávila-Villanueva et al., 2022). Gray matter and white matter are disrupted, affecting neurotransmitter systems. Bilinguals are shown to have lower white matter in a few tracks in the brain's medial temporal lobe connections, and though this is similar to the functions of monolinguals, bilinguals retain more information even with significant damage. The fornix, a tract connecting the hippocampus to the basal ganglia, is lower in the tracks. It is also shown to have less in the inferior longitudinal fasciculus (Gold, 2015). Plaques are beta-amyloid deposits that form slowly over the course of the disease. The pattern of when the disease develops starts in the neocortex and extends to the allocortex, hippocampus, basal ganglia, midbrain, and cerebellum. After symptoms in the brain become apparent, neurofibrillary tangles, also known as tau proteins, propagate along different pathways, beginning in the transentorhinal regions, then to the entorhinal cortex, hippocampus, and neocortical areas (Ávila-Villanueva, 2022).

Chronic stress from poverty, lifestyles, or depression is one of the significant effects of Alzheimer's disease, and experiencing this issue throughout a person's life can highly expose them to this. When a person experiences chronic stress, their amygdala activates the hypothalamus and brainstem, altering the prefrontal cortex's functioning. The nervous system can alter the hypothalamic-pituitary-adrenal axis, leading to increased cortisol secretion (Ávila-Villanueva, 2022).

B. Social Aspects

In the labor market, bilingual people earn slightly more than monolinguals primarily because of higher education. Bilinguals statistically work full-time and are less unemployed if fluent in both languages, have good socioeconomic status as a child, and have good cognitive abilities. For English speakers who can retain their second language, they have many economic advantages in the job market, but for Spanish-speaking bilinguals whose second language is English, they do not have as strong an opportunity. This is because their English skills as children were not adequately reinforced. Spanish-speaking individuals who are both very fluent in English and Spanish tend to earn higher sales commissions because they can attract more customers across diverse demographics (Gándara, 2015).

Chronic stress disrupts brain regions for memory and decision making, and working in tough stressful situations can enforce those issues especially while it is encouraged to be multilingual in the workplace to drive business, many bilingual employees face discrimination for speaking their native language among themselves, leading others to worry that they are possibly speaking negatively

about the company or others. In 1980, a case of Garcia v. Gloor sought to prohibit Spanish-speaking workers from being specifically required to speak English only, even during break hours. The only time speaking their native language is allowed is when a verdict concerns business (Gándara, 2015).

Soon after this case happened, the Equal Employment Opportunity Commission (EEOC) stepped in and said that employees should have the right to speak their native language during non-working hours, such as lunchtime. This suggestion prompted another case, EEOC v. Premier Operator Services, Inc., which sought to override the EEOC's suggestions for workplace harmony. This ironically shows how the United States values diversity and different languages, but also expects workers to speak English among themselves, in fear of negative talk (Gándara, 2015). The patterns of linguistic restriction not only shape workplace policies but also have significant consequences on the psychological well-being of bilingual employees.

Bilinguals in the workplace experience high stress and often feel discriminated against due to everyday exposure to discrimination. The person may have psychological behaviors like feeling depression, anxiety, or stress, and in these situations, the amygdala is very active. Negative social interactions can influence the amygdala to fire up because it processes fear, learning, and threat. In discrimination, the left amygdala processes negative stimuli. The right side processes the emotions, but the left side is more impactful. On the left side of the intrinsic amygdala, effects are independent, and significant exposures to discrimination are associated with activation in regions such as the anterior cingulate, anterior insula, and thalamus (Clark, Miller, & Hegde, 2018).

IV. CONCLUSION

Being multilingual is more than simply being able to converse in another language; it involves complex and advantageous neuroplasticity that can protect lifespan and general daily life skills. This review touched on the topics of managing multiple languages structurally, such as the gray matter (GM) thickness, which supports memory and goal maintenance, and the white matter (WM), which organizes dorsal and ventral language pathways. The neural pathways help support skills such as enhanced attention switching, code switching, inhibition, and cognitive control.

The cognitive advantages of being bilingual translate well into the real world, such as greater creativity, academic success, and more job opportunities. There is an excellent advantage for the older generation of bilinguals in delaying and fighting Alzheimer's disease by a few years. These advantages do not always apply to either the proficiency of the person's second language or to external factors such as discrimination. Discrimination may cause psychological stress, and understanding the bilingual brain will help people better appreciate the benefits and have the incentive to learn another language, too.

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Colorism in Indian Literature, Film, and Media

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ABSTRACT

Colorism is a mark of privilege and prejudice in India regarding beauty, status, and belonging. This paper studies colorism in literature, advertising, television, and digital media and its relation to identity and social interactions. First, I review peer-reviewed research on colorism in twentieth-century Indian literature, fairness-cream advertising, public affairs television, right-wing digital campaigns, psychological outcomes such as self-esteem and skin-bleaching behavior, and children's judgments of "Indianness." Then I present descriptive findings from a Google Forms survey of more than one hundred participants, which asked about self-identified skin tone, self-image, experiences of color-based bias, and perceptions of Indian media. In both scholarly books and the survey a general trend is observed: Fair skin gets treated as social capital, while darker skin gets stigmatized. Participants say their skin tone has shaped how they see themselves, that they have been discriminated against on the basis of color, and that media representations shape what beauty means. Together these results indicate that colorism in India is a system organizing representation as well as lived experience.

I. INTRODUCTION

In many Indian households, comments about skin tone are so common that they can feel normal. Relatives compare sisters, aunties offer remedies to "brighten" the face, and passing remarks about being "too dark" or "lucky to be fair" begin early in childhood. At the same time, Indian films, television, and advertisements repeatedly celebrate a narrow version of beauty based on lighter skin, "wheatish" complexions, and faces that match globalized ideals. This everyday mix of family talk and media imagery is one way that colorism takes root.

Colorism is different from racism. Colorism categorizes people within the same group by shade rather than race. In India, it's entangled with the caste system, colonial rule, class privilege, and beauty standards. Light skin is considered desirable, modern, and successful, whereas darker skin is often viewed as a flaw, an obstacle, or a sign of lower status. Particularly for girls and women, complexion may be a constant source of pressure, judgment, and self-monitoring (Chatterjee & Rastogi, 2024).

My interest in this topic is both personal and academic. In an Indian household I saw firsthand how two sisters were treated depending on their skin color. I was praised for being lighter and my darker sister got slammed with biases, comments, and comparisons in family and community spaces. But I also saw a significant difference between Indian and U.S. beauty standards. In many American spaces tan, dark bronzed skin is considered attractive or "healthy." In Indian spaces, fairness is idealized. This tension raises many questions. How is colorism portrayed in stories, shows, and advertisements? And how does this affect people's self esteem?

This paper focuses on colorism in Indian literature, film, and media, and how these cultural forms shape identity and social life. I bring together two approaches. The first is a literature review of peer-reviewed scholarship that examines colorism in twentieth-century Indian literature and culture, fairness-cream advertising, public affairs television, and digital media (Parameswaran & Cardoza, 2009), as well as psychological and developmental research on self-esteem, skin-bleaching, and children's judgments of nationality and status (Santhanagopalan et al., 2021). The second is a survey I conducted using Google Forms, in which more than one hundred participants answered questions about their skin tone, self-image, and experiences with color-based discrimination and media.

By placing these two pieces side by side, I argue that colorism in India is not just a background bias. It is an active system that appears in literature and storytelling, is marketed through cosmetics and television, is debated and weaponized online, and is internalized in people's everyday self-judgments and relationships. Literature and media provide scripts that people then carry into their lives.

II. LITERATURE REVIEW

Scholars of Indian literature have shown that colorism is entangled with twentieth-century stories of women, identity, and social mobility. Chatterjee and Rastogi talk about literary and cultural texts that show lighter skin as social capital for Indian women (Chatterjee & Rastogi, 2024). In many of the stories, they quote fair-skinned heroines as more marriageable, more respectable, and more worthy of love, whereas darker-skinned women are associated with rejection, hardship, and lower status. They also discuss writers who break this pattern and give darker characters agency and power. These authors turn fiction against the idea that beauty and worth are necessarily linked to fairness, proving that colorism is a social fact as well as a contested one.

Advertising research shows another major site where colorism is produced and sold. Magazine and television advertisements for fairness creams and personal care products in India are analyzed in this influential monograph (Parameswaran & Cardoza, 2009). They see recurring stories where a darker-skinned woman is unhappy, overlooked, or blocked in love or career, then uses a fairness product, becomes lighter, and finds romance, employment, and approval. In those short narratives, they not only sell products but also promote the idea that skin lightening brings change and upward mobility. In tracing these meanings, the authors link them to colonial racism, caste inequality, and rapid economic growth, arguing that fairness advertising legitimizes old hierarchies in the language of modern self-improvement.

Colorism also shows up in digital controversies where skin tone, religion, sexuality, and nationalist politics are questioned. Gajjala and colleagues examine an advertisement for the Indian company Dabur showing a lesbian couple celebrating the Hindu ritual of Karwa Chauth after using fairness cream (Gajjala et al., 2024). The ad tried to normalize a same-sex couple in a traditional ritual with skin-whitening as the object of the ad. The authors trace the online backlash, showing how conservative digital networks mobilized lesbophobia, misogyny, colorism, casteism, and Hindu victimhood stories. Their study

says fairness products are also about control of who belongs to the nation and under what conditions.

Shrestha adds a transnational angle by showing U.S. mainstream news coverage of India's skin-lightening industry (Shrestha, 2013). She says American media paint Indian consumers as "obsessed with fairness" based on Indian backwardness and tradition stereotypes, but not colorist pressures like in the US. In doing so, U.S. audiences distance themselves from colorism and American exceptionalism and "post-racial" progress, even though skin tone hierarchies and skin-lightening exist in many places globally. Overall, these media analyses show that colorism is local and global and is shaped by Indian histories as well as how India is spoken about around the world.

Psychological studies explain how individuals absorb and internalize the messages from their culture. The researchers, Pai and Deepakkumar, completed a self-report survey of young adult women living in Bengaluru, India, to assess the relationship between skin tone, amount of makeup used by participants, self-esteem, and participants' fear of having an unfavorable appearance evaluated (Pai & S., 2024). The researchers discovered that participants' skin tone had a significant correlation with self-esteem. Additionally, makeup use alone did not create higher levels of self-esteem among participants; rather, participants who reported a greater level of fear of negative appearance evaluations used greater amounts of makeup. The researchers suggest that in cultures that emphasize colorism, women are continually concerned about their appearance and use makeup as a coping mechanism to alleviate this fear of being negatively judged, and it does not provide them with an improved sense of self-worth.

Adbi and colleagues show that disempowerment affects interest in fairness products (Adbi et al., 2021). In experiments with Indian participants, women under psychological disempowerment desired stronger, more dangerous skin-lightening products that promised results faster. Preferences for men did not change in the same way. They link gender inequality and economic disadvantage to harsh fairness products. When women feel blocked or undervalued, changing their skin tone seems to be one of the few ways to attain status or control.

Choma and Prusaczyk study women of color in India and the United States and examine "skin tone surveillance," or the habit of closely monitoring and worrying about one's skin tone (Choma & Prusaczyk, 2018). They found that greater skin-tone surveillance is associated with greater dissatisfaction with skin color and more skin-bleaching behaviour. They also find that system-justifying beliefs, such as existing hierarchies, are natural and can make people accept colorist systems instead of going against them. This research argues that colorism is shaped not only by external pressures but by internalized expectations of what is normal.

Finally, studies with children show how early these patterns become pronounced. Santhanagopalan & colleagues had Indian children ages five to ten pick pairs of people with different skin tone, religion, and language (Santhanagopalan et al., 2021). Children were asked who was "more Indian". They generally picked lighter-skinned, South Asian, Hindu, and local-language speakers as more representative of being Indian and made judgments about intelligence and leadership using language and accent. These results show that children take in colorist and status-based ideas very early, before they become very clear about their implications.

The literature suggests an overall understanding of how the concept of colorism functions as a form of social capital in India through the lens of advertising, literature and other forms of cultural expression (Chatterjee & Rastogi, 2024), as well as the way in which both advertising and public affairs television present and discuss fairness-based narratives but do not necessarily challenge the existing power hierarchies that they are based upon (Parameswaran & Cardoza, 2009). In some cases, television programs focused on public affairs will reference colorism as a problem; however, they also tend to preserve the broader structures of caste, class, and patriarchy (Parameswaran, 2015). Research on digital controversy related to colorism demonstrates how it has connections to issues such as caste, nationalism, and queer politics, as demonstrated by studies of right-wing campaign strategies (Gajjala et al., 2024). Studies examining media coverage of fairness advertising globally demonstrate how India is portrayed to international audiences (Shrestha, 2013). Psychological studies demonstrate how these messages translate into self-monitoring behaviors, risk-taking behaviors, and system-justifying beliefs. Studies demonstrating how colorism influences self-esteem, makeup usage, and desire for severe skin-lightening products have been conducted by researchers such as Pai & S. (2024), Adbi et al. (2021), and Choma and Prusaczyk (2018). Additionally, research has been conducted with children to demonstrate how colorist judgments are becoming a component of how children develop their identities and sense of status (Santhanagopalan et al., 2021). Overall, this provides a framework for the questions that I am asking about people's experiences with colorism and media.

III. HYPOTHESIS

Using my understanding of literature, I have four hypotheses for this study. First, I expect that many respondents will report that their skin color has impacted the way they view themselves. Secondly, I expect that many respondents will report experiencing some form of bias or discrimination due to their skin color. Thirdly, I expect that many respondents will agree that the representation of skin tones in Indian media, literature, and advertising has influenced either how they feel about themselves or how society defines beauty. Lastly, I hypothesize that those identifying as dark skinned will experience at least as much, if not more, color-based discrimination than those identifying as light-skinned. Due to the small sample size and the exploratory nature of the design, this last hypothesis is treated as an exploratory one and therefore will not be subject to statistical testing.

IV. METHOD

A. Participants

The participants in this study consisted of volunteers who completed a survey conducted on Google Forms. The survey URL was distributed using social media, emails, texts, and QR codes for Las Positas Students to scan. A total of 107 responses were collected from participants who volunteered to complete the survey. Of the participants who took the survey, 76.6% reported their age to be between eighteen and twenty-five years old, while 23.4% of the respondents were either younger or older.

Volunteers were asked to report their gender identity, whether they are Indian, and their skin tone. The gender options included Male, Female, Non-binary, and Prefer not to say. Out of those respondents, 52.4% identified as female, 42.1% identified as male, and 5.6% were either non-binary or preferred not to say. On the question "Are you Indian?" 72.9% selected "Yes" and 27.1% selected "No." For skin tone, participants had the option to choose from Very fair, Fair, Medium/

Wheatish, Tan/Brown, Dark, or Prefer not to say. The largest skin tone group was the Tan/Brown group (40.2%), followed by Medium/Wheatish (23.4%), and the lowest being Very fair (7.5%), Fair (11.2%), or Dark (15%).

B. Measures

The survey contained a series of yes or no questions that displayed some of the main ways people have experienced colorism, including how it affects their self-image, the effects of media, and how people are discriminated against because of their skin tone. The first question asked “Do you feel that your skin color has ever affected the way you see yourself?”. The second question asked “Do you think the representation of different skin tones in Indian media, literature, and advertisements has affected your self-image or how society views beauty?”. The third and final question was to ask the participants “Have you personally experienced bias or discrimination based on your skin color? ”. Each question was intended to be very concise so that participants would complete the survey, while at the same time being connected to the core issues identified in the current literature.

C. Design

This study utilized a cross-sectional descriptive survey type of research design. The data was obtained at one point in time from an easily accessible and convenient sample, which was identified using personal, academic, and social media networks. Due to its design, there was no attempt made to manipulate the variables. Participants were not randomly assigned in groups, were anonymous, and I did not plan for a long-term follow-up with the participants. Due to this, the survey is limited on being able to report on the current thoughts and feelings reported by these respondents regarding their perception of skin tone, colorism, and media.

D. Procedure

In the beginning of the Google Form I introduced the topic of colorism and clearly stated that all of their answers would be kept completely anonymous. Participants had the option of completing the form on a phone or computer and completing it when they could. No participant provided their name or contact information to be included in the dataset used for the analysis, so participants remained fully anonymous in this study.

The survey then asked 7 questions. 1) What is your gender?, 2) What is your age group?, 3) Are you Indian?, 4) How would you describe your skin tone?, 5) Do you feel that your skin color has ever affected the way you see yourself?, 6) Do you think the representation of different skin tones in Indian media, literature, and advertisements has affected your self-image or how society views beauty?, and 7) Have you personally experienced bias or discrimination based on your skin color?. I used Google Forms summarizing tool to see what proportion of the participants had selected each answer choice to all of the survey questions about self-image, discrimination, and media influences. The results are discussed in the Results section.

V. Results

The responses showed that the sample was mainly composed of young adults connected to Indian culture. Most participants in this sample were between eighteen and twenty-five years old, identified as female, and described themselves as Indian. In terms of skin tone, “Medium/Wheatish” and “Tan/Brown” were the most frequently selected categories. For the self-image question “Do you feel that your skin color has ever affected the way you see yourself?” 54.2% of participants selected “Yes.” The majority of these participants perceive skin tone as an influence on their self-perceptions, and not simply a neutral characteristic. On the other hand, 32.7% selected “No,” implying they did not perceive their skin color to have impacted how they perceive themselves, and 13.1% chose “Unsure,” which could indicate conflicting experiences with the impact of skin tone.

When asked about the question, "Do you think the representation of different skin tones in Indian media, literature, and advertisements has affected your self-image or how society views beauty?" 63.9% responded "Yes," indicating that many participants believe media and society shape the way we see beauty as well as how we think of others and ourselves. 7.2% of those responded with "No," indicating they may not have perceived this influence. In addition, 28.9% responded "Unsure," suggesting they were unsure how to differentiate between media influence versus other types of influences.

When asked about personal experiences of bias, “Have you personally experienced bias or discrimination based on your skin color? ” 58.9% answered “Yes.” Many respondents felt that they had been treated differently, judged, or disadvantaged because of their complexion. 24.3% answered “No,” while 16.8% selected “Unsure,” perhaps because some experiences of bias are subtle or ambiguous.

Since this was an exploratory descriptive study with a small convenience sample, I chose not to conduct statistical tests to determine specific associations between skin tone categories and participants’ experiences of discrimination. In summary, the findings suggest that regardless of shade, most participants felt that their skin tone had influenced the way they viewed themselves, that they had experienced some form of color-based discrimination, and that Indian media and advertisements were part of determining what shade was the "ideal" complexion.

VI. Discussion

The goal of this paper was to bring together scholarly research on colorism in India with survey data on people’s real experiences. The survey results align closely with the patterns described in the studies.

Most importantly, a majority of respondents stated that they have experienced an impact from colorism on how they view themselves. In addition, the literature on psychology finds that colorism affects individuals' levels of self-esteem, self-surveillance, and level of anxiety related to appearance. Pai & S. (2024) found that there is a correlation between skin tone and self-esteem in young South Asian females, and that females who fear others will judge them based on their appearance tend to use more makeup as a result. Choma & Prusaczyk (2018) also established that frequent judgment of skin tone is correlated with insecurity and can cause a preference for skin bleaching. The survey responses demonstrate that colorism tends to be a common occurrence for many young adults who were raised under traditional Indian values.

Many respondents also reported that they have personally experienced discrimination due to their skin tone. This aligns with literary and media studies of how skin tones, especially darker ones, tend to be marginalized (Chatterjee & Rastogi, 2024). Darker skin tones tend to face greater marginalization on the basis of shade, while fairer skin is present as more desirable (Parameswaran & Cardoza, 2009). Such representation can make it easy for family, friends, and others to justify varying treatment based upon complexion.

Adding on to that, a large number of respondents stated that mass media and advertisements shape what is perceived as

beautiful. Several prior research studies have supported this response as it supports the argument that advertising for skin tone actively produces colorist beauty standards, as opposed to merely reflecting them (Parameswaran & Cardoza, 2009), as well as prior analysis of public affairs debates showing how television programs can name colorism a problem, yet continue to reproduce pre-existing hierarchies (Parameswaran, 2015). The fact that such a large number of participants cited media influences shows that audiences are aware and recognize the power of media and its influence on society.

The survey results also connect to research on identity and belonging. Santhanagopalan and colleagues show that Indian children already use skin tone, religion, and language to decide who seems "more Indian" and who looks like a leader or an intelligent person (Santhanagopalan et al., 2021). Combined with advertising that repeatedly rewards fairness and with public debates that rarely challenge deeper hierarchies, these early judgments can shape how people grow up understanding their place in the nation. The participants' reports of bias and self-image impact suggest that colorism continues to influence how they see themselves and others long after childhood.

The research has many important implications for media producers and marketers who will use this information to go against colorism. Media producers and marketers can contribute to changing beauty standards by creating and casting a broader array of skin colors in lead, positive roles, and by abandoning "before and after" fairness ads. The study also serves as an additional reminder to society that casual comments regarding complexion are not harmless, but instead, part of a larger social structure that shows children and adults how to evaluate each other based on skin color. Colorism should be included in discussions about identity, mental health, feminism, and social justice in Indian and South Asian communities.

VII. Conclusion

Through my research, I have demonstrated how fair skin can be used as a "social advantage" for women within Indian narrative contexts and how darker skin has the opposite effect (Chatterjee & Rastogi, 2024). Additionally, fairness advertisements promote the belief that lighter skin will result in beauty, while promoting the idea of colorism (Parameswaran & Cardoza, 2009). Public affairs television also uses debate to question fairness products while it leaves a lot of the social hierarchies of power intact as well (Parameswaran, 2015). The digital controversies also show how colorism is intertwined with issues of caste, nationalism, and queer politics and how these systems are interconnected (Gajjala et al., 2024). Other media analyses have demonstrated how the global reporting of skin-lightening in India is used to reinforce the concept of "backwardness" of Indians, and how there is a lack of coverage on similar colorist pressures somewhere else (Shrestha, 2013). Research on child development as presented by Santhanagopalan et al. (2021), indicates that children utilize physical appearance to evaluate their identity and status. Choma and Prusaczyk (2018) found connections between system-justifying beliefs and skin-toned surveillance and bleaching behavior.

In addition to this, the data from the survey provided more insight to answer the research questions for the study. Most of the respondents reported that there was an influence of their skin tone on their perception of themselves in some way, had experienced some form of color-based discrimination at some time, and felt that media, literature, and advertising help define what beauty is. These findings suggest that media, literature, and advertising may be a source of colorism that affects family relationships, dating, mental health, and more.

Overall, colorism needs to be changed starting with the narratives we create, images we normalize, the products we promote, and the words we say. Society needs to change its view on Indian beauty and identity, where every shade of brown has equal value and is not a deficiency to repair, but a quality to respect.

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FIGURES

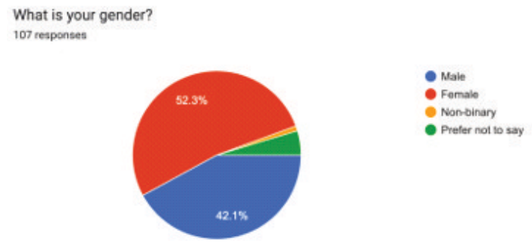

Figure 1. Participant gender distribution (*N* = 107).

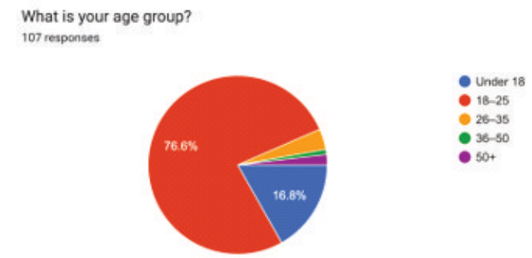

Figure 2. Participant age distribution (*N* = 107).

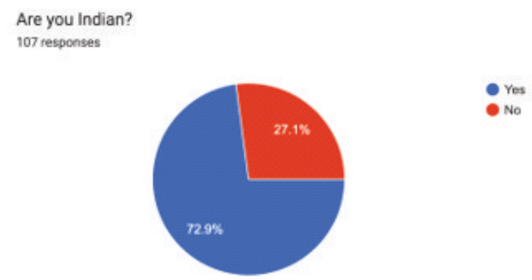

Figure 3. Percentage of respondents identifying as Indian (*N* = 107).

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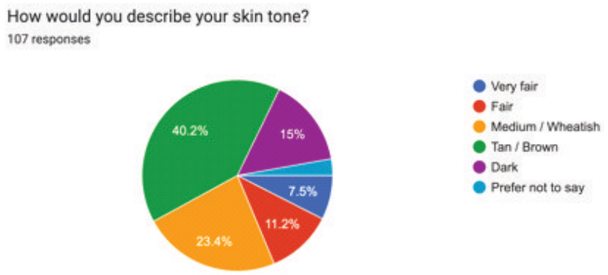

Figure 4. Self-identified skin tone categories among participants (*N* = 107).

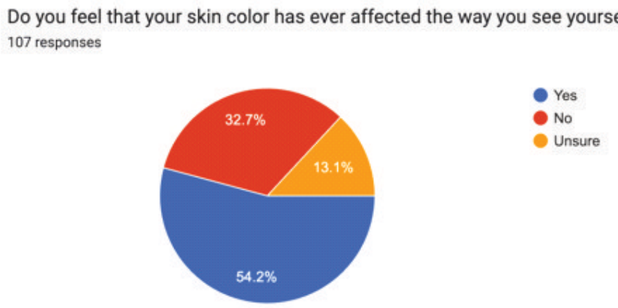

Figure 5. Percentage of participants reporting that skin color affected their self-image (*N* = 107).

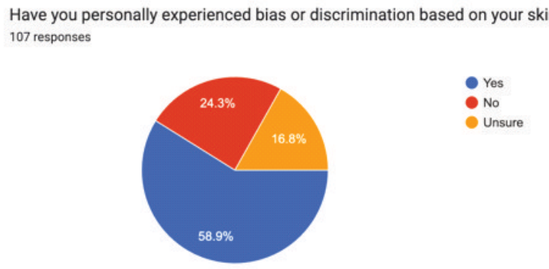

Figure 6. Percentage of participants reporting personal experiences of color-based bias or discrimination (*N* = 107).

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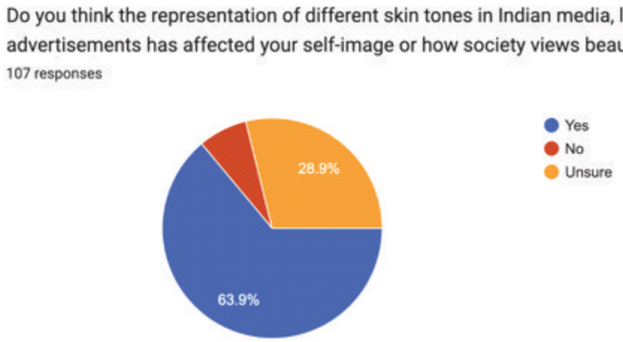

Figure 7. Participants' beliefs about whether Indian media shape beauty standards or self-image (*N* = 107).

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The Rise of Christianity in the Roman Empire

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ABSTRACT

This historical analysis discusses the growth of Christianity from a persecuted minority to the dominating force of the Roman Empire. By using social networks, trade routes, and the widespread use of the Greek language, the faith was able to prosper and spread the message of equality and hope, impacting all but especially marginalized groups such as women, slaves, and the poor. These groups were then able to find a community of shared values which further strengthened the religion. The paper transitions to focus on the reign of Emperor Constantine I and how his support in implementing the Edict of Milan and providing funds for Christian architecture and art was crucial to draw more attention to the faith. Furthermore, theologians such as Justin Martyr, Tertullian, Origen, Eusebius, and Augustine provided logical ideas and defence against Roman criticism by connecting Greek philosophy with Christian Scripture. Iconography such as the Spes Publica coin and graffiti like the Alexamenos Graffito are also discussed in this research which show the range of public attitude towards the flourishing religion. This historical analysis concludes that networks and groups, imperial support, philosophical inputs, and illustrations all had a significant impact on the expansion of Christianity throughout the Roman Empire.

INTRODUCTION

During the first century BCE and CE in the region of present-day Palestine, Jewish religious identity and beliefs often conflicted with that of Romans and the imperial religion. While the Romans believed in polytheistic paganism, Jews in this region followed the monotheistic faith known as Judaism, and the worship of a single God brought tension with the Roman faith of many gods and the divinity of the emperor. At this time, Jesus of Nazareth preached about the "kingdom of God," gathered disciples, challenged expectations, and emphasized love for God and neighbor. However, he was executed by crucifixion, known as Rome's most shameful punishment which made his movement seem dangerous and criminal in Roman society. His followers, known as Christians, began to organize and meet in the shadows of the Roman Empire, spreading the message of the gospel and salvation for all. The apostles also utilized the strengths of ancient Rome such as trade routes, quick communication methods, and the shared language throughout the empire to further expand the religion. Though Christians constantly endured suspicion, mistreatment, violence, and even state persecution for their beliefs, Christianity grew from a small, oppressed group into the official religion of the Roman Empire. Altogether, the rise of Christianity through networks, Constantine's policies, early Christian philosophers, and artwork both promoting and degrading the religion shows how a persecuted minority became a powerful religious and cultural force within the Roman Empire.

I. SPREAD OF CHRISTIANITY

The growth of Christianity throughout the Roman Empire was not random but understandable. Roman roads, Jewish networks, various forms of communication, as well as the appeal of the religion's tenets of equality, freedom, and hope enabled Christianity to spread throughout the empire.

Figure 1. Map of Paul's missionary journeys along Roman routes across the Mediterranean.

Christianity was able to flourish throughout Roman society by using the empire's framework. Roads maintained for military and commerce purposes also gave missionaries like the apostle Paul a relatively easy route between cities–so much so that archaeologist W.M. Ramsay notes that these roads "were probably at their best during the first century... Thus St. Paul traveled in the best and safest period" (Yamauchi, 1995). He visited large cities while traveling along these routes, and the book of Acts highlights that when Paul entered a new city, he often went to a Jewish synagogue (NRSVUE, 2021) to preach to people who were already monotheistic and familiar with the Hebrew Scriptures. This was also strategic because these synagogues were already rooted in trade and social networks, so conversion in one community could spark change in another. Paul not only preached but also established house churches and chose local leaders to guide these communities in faith as he continued his journey, helping retain Christian teaching in these areas even after he left (NRSVUE, 2021). Addressed to communities both within and outside the Roman Empire, Paul's letters followed these routes as well, enabling Christian ideas to continue to spread rapidly. Because Greek was widely used throughout the empire as well as in Paul's epistles and in many other Christian texts, these writings could be understood without translation which made it easier for scattered communities to see themselves as a part of a shared Christian identity (Smith & Stake, n.d.).

Figure 2. Fractio Panis, early Christian fresco of a communal meal, symbolizing shared identity among believers.

As Christianity spread throughout ancient Rome through preachings and letters, its social appeal contributed greatly to persuading people to join the religion. The apostle Paul expressed one of the many radical ideas of Christianity in his letter to the Galatians, that "there is no longer Jew or Greek; there is no longer slave or free; there is no longer male and female, for all of you are one in Christ Jesus" (NRSVUE, 2021). Because the

declaration of all being "one in Christ" broke down divisions of social class, ethnicity, and gender, grouping people into a single family of believers, the faith was especially appealing to the majority of the Roman population who held little status in society. The claim that a person's worth was not defined by these divisions was unusual in the ancient world, making the statement especially powerful in its time. Themes repeated throughout the Bible, along with teachings of how Christians should behave and worship, were also developed in Paul's letters. In his letter to the Romans, Paul described the message of the gospel as "God's saving power for everyone who believes" (NRSVUE, 2021), stressing that the faith was for all people of the empire regardless of hierarchies. This inclusiveness was seen during Christian gatherings, which created a shared emotional experience through combining teaching with commensality, singing, and prayer. In The Humanities, Henry Sayre describes early basilicas as "designed to elicit awe and wonder in worshipers" and "no one, it was hoped, could leave without their faith reenergized" after worshiping (2019). The beauty of music, emotion, and philosophy gave people a sense of spiritual meaning and community that set the religion apart from many others.

Figure 3. Interior of an early Christian basilica used for large communal worship.

In all of these ways, Christianity relied on the empire's extensive infrastructure such as roads, language, and social centers along with the faith's emphasis on equality, love, and emotion to appeal to Romans of various social classes. As it spread rapidly and rooted itself deeply throughout communities, eventually being adopted by the imperial family, Christianity grew into a central religion across the Roman Empire.

II. CONSTANTINE AND THE RISE OF IMPERIAL CHRISTIANITY

Emperor Constantine's rise to power marked a turning point in the history of Christianity, moving the religion from the shadows of Roman society to the center of its culture. By legalizing and protecting the faith and funding for Christian architecture and art, the emperor built a solid foundation for Christianity to flourish across the empire.

Constantine and Licinius, co-emperors of the western and eastern parts of the Roman Empire respectively, briefly allied in 313 CE to grant Christians and others "full authority to observe that religion which each preferred," so that anyone would be able to "observe Christian religion... freely and openly, without molestation" (Constantine, 313 CE). This right was one of several provisions recorded in the Edict of Milan, one of the first documents to recognize Christianity within Roman law, which helped the religion spread throughout the empire (Constantine, 313 CE). While Constantine did not persecute pagans, he "officially rejected pagan practices [and] openly favored Christians as officials" (Sayre, 2019), which shifted both social and political power toward the Christians and helped secure protection of the faith and its followers. When the constant fear of persecution was eliminated, Christians no longer had to worship in secret, and Christianity became

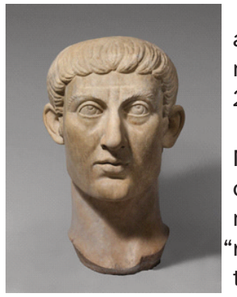

Figure 4. Marble head of Emperor Constantine I, 4th century CE.

appealing to many more Romans (Odahl, 2022).

The same Edict of Milan also ordered confiscated Christian meeting places to be "restored to the Christians without payment or any claim of recompense and without any kind of fraud or deception" (Constantine, 313 CE), ensuring that Christians regained their places of worship. Constantine not only made laws to protect the religion but also became a patron of the Church, funding the construction and restoration of many Christian institutions (Matthews & Nicol, 2019). According to Cultures & Values, Lois Fichner-Rathus notes that "two of the most important Early Christian churches are associated with the reign of Emperor Constantine: Old Saint Peter's Basilica and the Church of the Holy Sepulcher," the basilica being built over the site believed to be Saint Peter's tomb and the church over the sites of Jesus' crucifixion and tomb (2024). While these large, public churches provided places of worship and gathering, they also symbolized the growing power of Christianity and its imperial support. At the same time, Constantine allowed Christian imagery such as Spes Publica coins issued in Constantinople ("Nummus - Constantinus I," 2024), the Chi-Rho standard, and religious symbols to appear throughout the empire. As Romans repeatedly encountered these symbols and large Christian institutions in their daily lives, Christianity became a normal part of public life, encouraging more people to adopt the faith over time.

Figure 5. Icon of Constantine and the Council of Nicaea holding the Nicene Creed, illustrating imperial support for Christianity.

In order to preserve peace in the Roman Empire and promote doctrinal unity as Christianity grew, Constantine convened the Council of Nicaea in 325 CE, the first ecumenical council of Christian bishops (Sayre, 2019). The council was originally convened to address the belief that "[the] Father and Son were not of the same substance, and therefore not coequal and not coeternal" (2019), a teaching that threatened harmony in the empire. This belief was rejected when the council produced the Nicene Creed, which "expresses all that Christians believe about the nature of God and his son, Jesus Christ" (Constantine, 313 CE), helping to prevent new controversies from arising. With imperial authority backing the creed, Christianity became more unified and stable, which enabled the religion to expand within Roman society.

By providing Christians with protection and influence, these policies changed the cultural and religious life of ancient Rome. While emperors who followed would eventually make the faith the official religion, Constantine set the foundation that allowed Christianity to become widely accepted throughout the Roman Empire.

III. EARLY CHRISTIAN PHILOSOPHY

An apologist of the second century who had been a pagan before conversion, Justin Martyr is considered one of the earliest Christian philosophers with surviving works.

While attending several philosophical schools (Justin, 1900), he became convinced that the Logos, otherwise known as the Christian "Word", was the true understanding of divine reason that Greek philosophers had been seeking. He claimed that each discovery made by thinkers such as Plato was a part of the Logos fully revealed in Christ, allowing Justin to respect Greek thought while insisting that Christianity completed it (Justin, 2017). Only a few of his works remain, two of them being The First and Second Apologies, in which he "explained the nature of the Christian religion and asked for the state's tolerance for Christian worship" (Fichner-Rathus, 2024), defending Christians against accusations such as atheism, immorality, and disloyalty to the empire. Despite his efforts, Justin's writings failed to bring about the response he was looking for, as he was eventually condemned and accepted martyrdom in Rome under the anti-Christian laws, and has since been remembered as "Justin Martyr." Using his explorations of both philosophy and religion to create bold assertions about the Logos, he helped form a new perspective on Christianity as the completion of truths Greek philosophers had already started to discover.

Figure 6. Icon of Saint Justin Martyr with martyr's crown, symbolizing his martyrdom and teaching.

If Justin represents Christian openness to Greek philosophy, Tertullian of Carthage represents a more cautious take. As another second-century apologist, Tertullian's remaining works such as "To the Martyrs" and "To the Nations" were addressed to Christians in prison and pagans respectively (Wilken, 2024). Like Justin, he defended Christians against allegations regarding atheism and immorality largely in his Apology, where he questioned Roman officials as they "say we are atheists, and will not be at the expense of a sacrifice for the life of the emperors; and if the first be true, the consequence is just, for if we will not offer to the gods for ourselves, it is not likely we should do it for others" (Tertullian, 2019). In other words, Tertullian argued that Christians do not deliberately disobey the emperor; rather, they refuse sacrifices because they only worship one God. While Justin connected philosophy and Christian faith to speak to non-Christians, Tertullian often issued bold warnings to other Christians about the dangers of pagan ideas. His strict view that Christians should resist personal desires as well as pressures from society helped create a stronger, clearer sense of Christian identity within ancient Rome.

The first great systematic theologian, a thinker who organizes a religion's beliefs in an ordered way, is widely considered to be Origen of Alexandria from the second century. He "laid the foundations of philosophical theology" (Edwards, 2014) by using Plato's philosophy to discuss the Christian God, freedom, and salvation. His most philosophical work, On First Principles, is thought to be

Figure 7. Portrait of Tertullian of Carthage, a second-century Christian apologist known for defensing against pagan criticism.

the first attempt to present Christian teaching in a systematic way. Origen argued that Scripture has different layers of meaning, declaring that "just as man is said to consist of body, soul, and spirit, so also does holy Scripture" (Origen, 2023). Based on Middle Platonic ideas, Origen believed salvation meant a free, rational return of the soul to God through Christ. Although his bolder ideas were rejected by the Church, the questions he brought up as well as the debates he held had a long-lasting influence on Christian philosophical theology (Edwards, 2014).

Narrating the story of Christianity from the apostles to his own time, third-century Eusebius incorporated martyrdoms, documents, and lists of bishops in his Ecclesiastical History. Often considered philosophical interpretations of history rather than historical records, his works discuss the progression of events from Christ's life to the apostles' spread of the gospel across the Roman Empire to Constantine's policies ("Eusebius of Caesarea," 2019). While others mourned deaths, he wrote about how they were not just tragedies, but trials that in his view revealed the truth of the Church (Eusebius, 2007). Eusebius also wrote the Life of Constantine, in which the emperor was portrayed as being chosen by God to protect and advance the Church. Although modern scholars criticize his idealization of Constantine, the book nevertheless presents a new Christian political theology where imperial power was focused around the "city of God" rather than pagan gods (Eusebius, 2007). By interpreting Roman history as part of God's plan to guide and protect the Church, Eusebius enabled Christians to see their empire from a new perspective.

Figure 8. Icon of Origen of Alexandria holding a scroll, symbolizing his role as an early Christian theologian and interpreter of Scripture.

Described by the Stanford Encyclopedia of Philosophy as "perhaps the greatest Christian philosopher of Antiquity and certainly the one who exerted the deepest and most lasting influence" (Tornau, 2020), Augustine of Hippo's ideas on sin, grace, freedom, and the spirit have transformed Western thought for centuries. Augustine's famous Confessions is both an autobiography and a reflection of memory, time, and desire. In the first few books, he explores the themes of rhetoric and theater until he opens Paul's letters (NRSVUE, 2021) and undergoes conversion. Although there have been many autobiographies detailing social, political, or military matters, "Augustine's intimate self-scrutiny and inquiry into the significance of life were new" (Fichner-Rathus, 2024). Augustine then reflects on the nature of time and compares it to God's eternity, arguing that it is not

Figure 9. Sixth-century Syriac portrait of Eusebius of Caesarea holding a scroll, from the "Rabbula Gospels."

endless time but a different form of being altogether (Augustine, 397 CE). Confessions contains Scripture, personal narrative, and philosophical analysis, making it an example of a Christian self-reflection.

Following the gradual acceptance to Christianity, many pagans in Rome began to blame the Sack of Rome in 410 CE on the Christians for weakening traditional cults (O'Donnell, 2019). In the City of God, Augustine remarks that Rome was built with earthly glory, "which equates happiness with the prosperity of the Empire, thus falling prey to evil demons who posed as the defenders of Rome but in fact ruined it morally and politically" (Tornau, 2020). He compares two symbolic cities: the earthly city, formed by self love and without God's will, and the heavenly city, formed by the love of God and satisfaction of self (2020). History, in Augustine's perspective, is a parallel between creation where non-Christians and Christians coexist to final judgement where the two populations will be eternally separated (O'Donnell, 2019). Augustine heavily emphasizes Paul's letters and the book of Psalms, taking both Greek and Roman ideas about an ideal happy life, and re-evaluating them from a Christian viewpoint emphasizing the connection one has with God.

Figure 10. Icon of Saint Augustine of Hippo as a bishop carrying a book, symbolizing his role as a Christian thinker and author.

Behind all of these philosophers is the Bible itself. The New Testament, specifically the Gospel of John and the letters of Paul, provide and explain essential vocabulary such as Logos, grace, faith, creation, and the meaning of Christ. Early Christian philosophers both followed and analyzed these texts to gain insight about God and humanity, and these figures show that while early Christianity contained rituals and moral rules, it was also intellectual. Justin Martyr and Tertullian debate how Greek philosophy ties into the gospel. Origen, on the other hand, claims that God's goodness is connected to human freedom, while Eusebius explains the Church's story. Augustine dives into the relation of memory, desire, and history to affirm his belief that only the love of God can anchor a human life, and the steps that each of these philosophers took for their beliefs changed the course of the religion.

Figure 11. Manuscript page of Augustine's City of God, opening text, c. 1470.

IV. ART AND SYMBOLISM IN EARLY CHRISTIANITY

The eighteen millimeter copper alloy nummus, a bronze coin produced in Constantinople during the fourth century, may appear to be an ordinary rusted coin but it is physical evidence of Rome's radical shift from paganism to Christianity. Although it is one of the smallest surviving artifacts from this era, the portrait, Chi-Rho, and the military standard on it all symbolize the emperor's authority, his military's role in the rise of the new religion, and the new union of imperial power and Christian faith.

On the obverse, the side profile of the "laureate head of Constantine" ("Coin," n.d.) wearing a laurel wreath shows striking similarity to earlier Roman emperors even as he reigns in a new religious direction. Along the rim of the coin is an inscription in Latin "CONSTANTI-NVS MAX AVG" ("Nummus - Constantinus I," 2024) directly translating to "Constantine, greatest emperor" (Smith & Stake, n.d.).

The reverse shifts the focus from individual rule to the power of his imperial army, represented by a labarum carrying the Chi-Rho symbol and piercing a serpent beneath it. The imagery highlights the army's victories over their enemies, "[the] serpent representing his defeated rivals" ("Coin," n.d.), under the guidance of the Christian God. Striking through the labarum is inscribed Latin, reading "SPES-PVBLIC A" ("Nummus - Constantinus I," 2024), which translates to "the hope of the public" ("Spes Pvblica," 2019)

Figure 12. Constantine I Bronze Nummus with Chi-Rho Standard.

while underneath the serpent lies Constantinople's mint mark "CONS" ("Nummus - Constantinus I," 2024).

These inscriptions together give the idea that both Constantine's military and city brought and rooted a sense of security to the empire. This coin type, according to the British Museum, is the first to clearly illustrate Constantine's new Christian faith ("Coin," n.d.) and can be seen as foreshadowing the broader Christianization of the Roman Empire. Though small in size, this coin passed from the hands of everyday citizens to powerful nobles and silently spread Christianity across all social ranks and associated imperial power with Christian faith. The iconography of the nummus condensed political ambitions, religious identity, and military power into an easily accessible mosaic of imperial ideology that brought hope and faith throughout the Roman Empire.

The Alexamenos Graffito, a piece of Roman graffiti scratched into a wall on the Palatine Hill in Rome, is a small but powerful example of how Romans viewed Christianity in the late second and early third century CE. The combination of the donkey-headed crucified figure, the small worshiper, and the mocking inscription shows how Christianity was seen as foolish and shameful to many ancient Romans. As this graffiti was one of the earliest surviving illustrations of the crucifixion, it is now considered an important piece of evidence for both the spread of Christianity and the hostility it brought.

At the center of the illustration, a thin cross bearing a human figure with outstretched arms, stiff torso, and parted legs is visible. The most striking feature, however, is the "ass's head" (Fowler, 2017), a head resembling a donkey's with its long, pointed ears and extended snout. To the left stands a figure commonly referred to as Alexamenos, who is "quite short in comparison to the other one" (2017), drawn in a similar style but with a clearly human head that looks up toward the crucified figure with one hand raised, a gesture that could be interpreted as greeting or worship.

Richard Viladesau, a professor at Fordham University, explains that beneath the scene, in Greek capitals, the caption reads "ΑΛΕ ξΑΜΕΝΟC CΕΒΕΤΕ ϑΕΟΝ" which directly translates to "Alexamenos worships [his] God" (2006), making the drawing's intent to mock Christians undeniable. Jesper Svartvik

also notes in a footnote that "it is not obvious why the verb (sebete) is in the plural" (2005), a verb meaning "to worship" or "to respect." He offers the following explanations: "one (less likely) explanation is that Alexamenos represents a whole group, i.e., all Christians. The more likely explanation is that it is a misspelling due to the itacism, i.e., the tendency to pronounce ai (and other letters or combinations of letters) as [e]" (2005). This graffito was also drawn in a "paedagogium, a boarding school for imperial page boys" (Nelson, 2024), so, taken together, these details suggest that it was inscribed by an ordinary citizen, which indicates that Roman resentment toward Christians had seeped into everyday society.

As a whole, the Alexamenos Graffito suggests that early Christians were not only persecuted by officials but also ridiculed by ordinary citizens throughout the Roman Empire as well. By mocking a man worshiping his God in the form of a crucified individual with a donkey's head, the illustration shows how absurd and shameful the Christian message was to many Romans, specifically the younger generation. However, the existence of this engraving confirms that Christianity had already spread widely enough to be ridiculed even in casual graffiti, demonstrating how the cross had become such a meaningful symbol of the religion. This illustration condenses mockery, misunderstanding, and hostility and shows that Christianity had already become a recognizable presence throughout Roman society.

Figure 13. The Alexanenos Graffito.

CONCLUSION

The rise of Christianity originated as a small, monotheistic movement but over time transformed the larger, polytheistic Roman Empire's culture, politics, and religious status. After Jesus of Nazareth was executed, missionaries emerged and spread the message of the gospel and salvation using Roman roads, the widespread use of the Greek language, and active social networks throughout the empire. This message of unity and compassion for one another under a forgiving God was especially appealing to marginalized communities and minority groups such as women, slaves, and the poor. Centuries later, Constantine's rise to imperial power introduced Christian-favored policies, support for the religion and their architecture, and imperial backing which guided the faith toward becoming the official religion of the Roman Empire. Thinkers such as Justin Martyr, Tertullian, Origen, Eusebius, and Augustine used preexisting Greek philosophy as well as Scripture to explain and defend Christianity in a logical way to contradictory Roman views. Art from this era both supported and ridiculed the faith and shows how visible Christianity was in everyday Roman society, and Christianity continues to spread hope and equality today but also faces harsh criticism and debate similarly to the first centuries. Studying Christianity in Culture and Arts I has turned the religion's rise in Rome from a list of historical facts to a set of real stories of persecuted Christians, Roman rulers, philosophers, and everyday citizens. Ultimately, the rise of Christianity from a persecuted minority into an influential religious and cultural force is revealed with the use of Roman and Jewish networks, Constantine's support, works of philosophers, and both promoting and ridiculing artwork.

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On The Value of Mexican Golden Age Cinema

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ABSTRACT

Mexican cinema, and more over Latin American cinema, is deeply understudied and overlooked by both common moviegoers and film studies academics. As someone who grew up watching Mexican Cinema, and especially movies of the Golden Age, which spanned from 1936 to 1957, I wanted to put an end to this ignorance and bring an academic and Latino perspective to cinema. I did this by exploring how Mexican directors of the Golden Age of Mexican Cinema use cinematography, direction, and mise-en-scene to tell unique stories and express the national and revolutionary character of 20th century Mexico.

For the Honors component of my Humanities course, I decided to take a trip down memory lane and analyze some of the films that were a part of my childhood. I did this assignment for Professor Wing Brooks's Intro to Film Studies class because I wanted to analyze the Golden Age of Mexican Cinema and understand why the movies of this era are critically and academically acclaimed both in Mexico and abroad. To complete this project, I read several books and articles, including Prof. Charles Ramírez Berg's The Classical Mexican Cinema, to understand the filmic techniques Mexican Golden Age directors used to enhance the beauty of their films. I also watched many movies from the auteurs of that era. I chose to analyze Fernando de Fuentes's El compadre Mendoza and Vámonos con Pancho Villa, Emilio 'El Indio' Fernández's María Candelaria, Enamorada, and La perla, Luis Buñuel's Los olvidados and Viridiana, Alberto Gout's Aventurera, Juan Bustillo Oro's Dos monjes, and Julio Bracho's Distinto amanecer. I analyzed their direction, cinematography, and mise-en-scene, the key cinematic elements of every movie, to understand how they expressed their commentary on Mexican society.

My research and screenings resulted in a video demonstrating visual examples of filmic language to explain how and why Mexican Golden Age Cinema is special. To create the video, I wrote a script, recorded audio of myself reading it, and then edited clips and images together to accompany the script. My video essay fully analyzes the history, context, and artistic intention of the Mexican auteurs of the Golden Age. I felt that a video essay would be the best way to demonstrate and analyze film. By playing a clip that the audience can see and hear as I follow up with an extensive verbal analysis, it allows for less confusion about what is being described and interpreted. As stated before, I focused on the mise-en-scene, cinematography, and direction of these movies and how that serves to tell a story and comment on Post-Revolution Mexico. The Golden Age of Mexican Cinema is traditionally set from 1936

to 1957 and occurred due to Mexico's rapid institutionalization, cooperation from the United States, and a lack of competition from Hollywood movies because of World War II (Roddick).

The first director I analyzed was Fernando de Fuentes who made movies set during the Mexican Revolution (1910-1920). De Fuentes had a pessimistic view of the PRI, or the Institutionalized Revolutionary Party, the political party that dominated Mexican politics after the revolution, and believed that they failed to complete the reforms they promised in the Revolution. His movies reflect that by criticizing different revolutionary factions. In Vámonos con Pancho Villa, de Fuentes demystifies Pancho Villa, a Mexican Revolutionary who famously implemented banditry and guerrilla tactics into his fighting. The film follows six men who call themselves 'los leones de San Pablo' (the lions of San Pablo) and join the Villista faction to fight against the counterrevolutionary government. In the beginning of the movie, Villa is usually depicted in sunlight and is well regarded by the people around him. But when the sun goes down, that's when Villa reveals his danger to the protagonists by giving orders that get the leones killed. The most famous of which is in the finale, when the oldest member Tiburcio, is ordered by Villa to kill the youngest member of the leones because he has smallpox. The order is given in the darkness outside a passenger train, "In de Fuentes's universe, many corrupt government official's most reprehensible deeds occur in darkness, including the murder of Gen. Nieto in El compadre Mendoza, and Villa's command that Tiburcio kill and cremate his friend in ¡Vámonos con Pancho Villa!" (Ramírez Berg 74). In an earlier film by de Fuentes called El compadre Mendoza, we follow Rosalío Mendoza, a wealthy landowner who sells weapons for multiple belligerents of the revolution. Mendoza later befriends Zapatista General Felipe Nieto, even making him his son's godfather. In the end of the movie, a Carrancista commander convinces Mendoza to trick Nieto into coming to his estate where an ambush will kill him. Mendoza agrees so he can keep his estate safe. This order is given in darkness; this cinematic motif proves that de Fuentes had a unique and effective film style.

The second of the auteurs I focused on is Emilio 'El Indio' Fernández. He is most famous for the film María Candelaria which famously won the Cannes Grand Prix Price (now called the Palme d'Or) being the only Mexican film to do so and putting Mexico on all filmmakers' radar (Film Studies). The film's mise-en-scene or ensemble of acting, sets, production, lighting, sounds, and shots firmly set the movie in a unique Mexican setting while telling a cautionary tale on discrimination. The story follows María Candelaria, an indigenous woman who wants to get married and live a normal life but isn't allowed into town because she's the daughter of a prostitute. "The film's cinematography, done by the prolific Gabriel Figueroa, who frequently collaborated with Emilio Fernández, is breathtaking: wide-open skies scattered with thin clouds, sparkling waterways, mountains of flowers. In many ways, María Candelaria is a love letter to the natural beauty of Mexico" (Hrabik). In an early shot, Candelaria is on an indigenous chalupa, a type of canoe, and paddles to town as the camera pans over and shows the Indigenous people around the lake, blending into the environment. The placement of the indigenous people to make it hard to distinguish them from the land represents their unchallengeable claim that Mexico's land belongs to them. The imagery of chalupas, central Mexican clothing, pottery, and even the spoken accent, are all unique characteristics of Xochimilco, a city that is in the heart of the former Aztec Empire (Department of Modern and Classical Literatures and

Cultures of Rice University). These elements both add to a unique story and send a signal to the world that this is a Mexican film where the people of Mexico are being represented for who they actually are.

The last auteur I studied is Luis Buñuel. Buñuel is actually a Spanish national and immigrated to Mexico in the 1940s to escape the Spanish Civil War and the Nazi Occupation of France because of his communist views. Buñuel made surrealist movies believing that surrealism was a lifestyle that permitted him to accurately criticize the bourgeoisie and the autocratic PRI. His masterpiece is Los olvidados which follows the story of an impoverished boy named Pedro who tries to escape the influence of juvenile delinquent El Jaibo. We see Buñuel's surrealist style shine in a dream sequence that happens after Pedro unintentionally becomes the accomplice of a homicide committed by El Jaibo. His dream is odd, slow motion is used as his mom carries what looks like a severed head. Under Pedro's bed is the boy El Jaibo murdered and he's laughing with blood on his face. Yet we don't hear his laugh. Instead we hear the audio of chicken clucks as chicken feathers rain on them (Buñuel). This avant garde mix of audiovisuals puts the audience on edge and creates a singular experience in Mexico's cinematic catalog.

My in-depth video essay analyzes these auteurs and other work from the same era of Mexican history; it is 27 minutes long and is split into 6 unique parts. The first minute and a half is an introduction to cinema studies where I express my goal to explain what the Golden Age of Mexican cinema is, why it happened, and why it's considered the summit of Mexico's cinematic patronage. The next section of approximately 3 minutes explains the history of Mexico in the late 19th century during the Porfiriato and the Revolution of 1910. I explain how Mexico began as a documentarian society and after influence from the egalitarian, agrarian, and socialist movements of the Revolution, Mexico began to develop its first narrative films with El automóvil gris directed by Enrique Rosas in 1919 (Ramírez Berg 33-51). Part 3, Synergy, is also 3 minutes long and covers how sound saved the Mexican film industry in the 1930s; it also discusses how geopolitical events around Mexico such as World War II, the Good Neighbor Policy, and the Mexican Economic Miracle allowed a cinematic golden age to happen (Vazquez Reyes). The two minute long part 4 explains simple Mexican pop culture. Now part 5 is my extensive 15 minute analysis on the films of de Fuentes, Fernández, and Buñuel and other minor Golden Age filmmakers. The last 3 minutes is a short epilogue explaining the history of Mexico's cinema after the Golden Age and the rise of el nuevo cine mexicano in the 1990s. In total, this video took me around 36 hours to create as I edited an average of 8 hours for 6 days to get all the audio and video recording done on time for this project.

While this project could have frustrated someone else, I did it with love. I've always loved movies; as a child growing up watching Mexican comedies from the 40s and 70s, it saddened me that I couldn't talk to anyone about these movies as no one else my age had seen them. Even now as a film major in community college, I rarely find anyone that has seen a Mexican movie let alone one from the Golden Age. Unless it's for an assignment or they're Mexican. This project was more of an excuse to get this paper's reader to have exposure to my culture and be inspired to enjoy Mexico's media. It connects to my Film Studies class because I am studying the history and techniques involved in the directing, mise-en-scene, and cinematography used by de Fuentes, Fernández, and Buñuel. These terms are more than vocabulary, they are a manual that allows me to explain why and how movies are made and

are art. It allows me to prove the merit of the title 'Mexican Cinematic Golden Age' and better understand these terms both academically and as a viewer, allowing me to understand these movies with a more educated mindset than when I was a kid.

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RESOURCES

HYPERLINKS TO VIDEO ESSAY & RESEARCH NOTES

- https://www.youtube.com/watch?v=RX6C5DFw4G4&t=1s
- https://docs.google.com/document/d/10-2TCwTA4qHHgkSIKNRprDhYMSONjZ-vO5g1POrqEIuE/edit?usp=sharing

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Imperial Identity and Political Power in Mughal Miniature Painting

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ABSTRACT

This paper examines how Mughal miniature painting functioned as a deliberate visual strategy to construct and communicate imperial identity during the reigns of Akbar, Jahangir, and Shah Jahan. Rather than serving as mere decoration, these paintings operated as political and ideological tools that reinforced the emperor's authority across a vast and diverse empire. Through close visual analysis of key works, such as The Defeat of Hemu at the Second Battle of Panipat, Jahangir Preferring a Sufi Shaikh to Kings, and Shah Jahan Receiving His Sons and Asaf Khan, this study demonstrates how composition, symbolism, and iconography were used to elevate the emperor beyond the human realm. Akbar's imagery emphasizes conquest, order, and legitimacy through dynamic narrative scenes, while Jahangir's paintings shift toward allegory and cosmology, presenting the emperor as spiritually and morally superior. Under Shah Jahan, visual representation becomes increasingly formalized and abstract, portraying the emperor as a timeless and divinely sanctioned figure at the center of a perfectly ordered world. Across these three reigns, Mughal miniature painting evolves from narrative propaganda to symbolic and idealized representations of kingship. By analyzing these visual strategies, this paper argues that Mughal paintings were not passive reflections of power but active instruments in shaping imperial ideology, public perception, and historical memory.

INTRODUCTION

The Mughal Empire marked itself out not only in the fields of military conquest and administrative innovation but also on the visual plane in the early modern Muslim world. At its very centre, this artistic tradition lay the imperial miniature – a small yet impressively minutely painted piece which was not merely an ornament but a skilfully crafted presentation of royal identity. These pictures were in albums, court chronicles, and presentation manuscripts and formed part of the visual ideology of the empire. Dating from the mid-16th century and further onwards, Mughal miniature painting was a very important tool through which emperors demonstrated their power, divine grace, and cultural superiority.

While traversing an enormous empire consisting of multiethnic, multilingual, and multi religious communities, the image of the emperor had to go further and be heard better than the ruler ever could. Therefore, painting became a replacement for imperial presence. These images, whether they depicted the emperor in the wars, in the courts, in the meetings with the foreign envoys, or in the cosmic or allegorical settings, conveyed more than the likeness; they entailed the power, discipline, virtue, and divinity. The Mughal miniature was not only

art; it was propaganda, diplomacy, scripture and history diluted into pigment and gold leaf.

In this essay, three of the most influential Mughal emperors are examined to demonstrate how these leaders used miniature painting as a visual strategy to create an imperial identity. The leaders include Akbar (r. 1556–1605), Jahangir (r. 1605–1627), and Shah Jahan (r. While working under the same visual tradition, each ruler developed unique aesthetic schemes telling us about his political aims, philosophical orientation, and the perception of kingship. Akbar's images emphasized conquest, order, and religious plurality; Jahangir's emphasized cosmology, spiritual alignment, and moral superiority; Shah Jahan's emphasized abstraction, divine perfection, and timeless elegance. Through detailed case studies and visual analysis, this paper demonstrates how the miniature painting functioned as a deliberately crafted political instrument to support dynastic legitimacy and reinforce the emperor's symbolic role as the center of the universe.

A clear example of how painting operated politically can be seen in The Defeat of Hemu at the Second Battle of Panipat (Figure 1), produced in the Akbarnama. Here, Akbar—only thirteen years old at the time of the actual battle—is shown heroically atop a horse, calm and central amid a chaotic clash of armies. This is not a documentary scene but a visual myth: Akbar's presence is exaggerated, his position central and elevated, and his divine aura subtly implied through composition and scale. Such works helped transform historical events into imperial narratives, where the ruler always emerged victorious, chosen, and wise.

Jahangir, Akbar's son, took a different approach. In Jahangir Preferring a Sufi Shaikh to Kings (Figure 2), painted by Bichitr, the emperor is portrayed in an allegorical realm: seated on an hourglass throne, flanked by angels, haloed by the sun and moon, and receiving a book from a holy man. The Ottoman Sultan, King James I of England, and Bichitr himself wait below in deferential positions. Jahangir is not shown governing or fighting; instead, he rules over time, spirituality, and world order. This self-sculpted image of cosmopolitan superiors and spiritual leadership was a savvy change from his father's heroic naturalism to the symbolism of philosophy.

During the reign of Shah Jahan, the image of the emperor became more formal and idealised. Shah Jahan Receiving His Sons and Asaf Khan from the Padshahnama; Fig 3 shows him as a remote, calm figure defined by symmetry, marble thrones, and celestial light. In this case, Shah Jahan is not a character in the scene but an icon of the cosmic structure. His idealised face, jewel-toned robes and stylised gestures radiate eternal kingship. The message is clear: this emperor is no longer appointed by God, but he is the image of perfection on the earth.

By attending to these visual artifacts head-on, this paper shows how Mughal miniature painting was critical to producing and disseminating imperial identity. By way of colour, scale, iconography, and composition, these paintings placed the emperor as superior over space and time. By mythologising victories on the battlefield, sanctifying spiritual roles, or taking monarchy out of human acts and making it into cosmic perfection, the Mughal miniature functioned as a deliberately written visual text that elevated emperors out of human realms and into history book fame, but as more than conquerors, as such eternal signifiers of order and justice, as well as divine will.

II. HISTORICAL AND CULTURAL CONTEXT

A. Akbar (r. 1556–1605): The Architect of Imperial Visual Culture

During the reign of Emperor Akbar, there was a transformative period in the history of the Mughal miniature painting. Akbar appreciated the power of visual narratives and thus set up a royal atelier which combined Persian art traditions with local Indian styles. This fusion gave birth to a unique Mughal aesthetic with dynamic compositions, bold hues, and fine detailing.

One of the boldest endeavours supported by Akbar was the Akbarnama, which was the chronicle of his rule. The manuscript contains such illustrations as Akbar surveying the building of Fatehpur Sikri and so on, not only as a record of historical fact but also as visual propaganda of Akbar's role as a fair and visionary ruler.

Figure 1. Akbar Inspecting the Construction of Fatehpur Sikri.[1]

In this painting, Akbar is seen observing the building of his new capital, which is a symbol of his love for architectural innovation and ruling. The composition puts Akbar at the centre putting emphasis on his authority and participation in state matters.

B. Jahangir (r. 1605–1627): The Connoisseur of Art and Nature

Jahangir, son to Akbar, inherited his late father's love of art but drove Mughal painting in a more naturalistic and individual direction. During his reign, European techniques of perspective and chiaroscuro that were introduced through diplomatic contacts were accepted.

One good example is Jahangir's Preference of a Sufi Shaikh over Kings, where Jahangir is presented awarding a Sufi saint with preference as compared to other rulers such as the Ottoman Sultan and King James I of England. This allegorical painting highlights the spiritual leanings of Jahangir as well as his claim to moral superiority over other rulers.

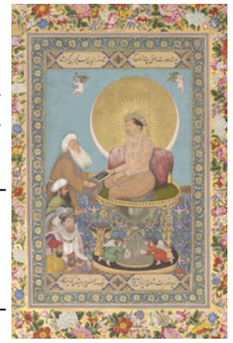

Figure 2. Jahangir Preferring a Sufi Shaikh to Kings.[2]

The work has a hierarchical organisation with Jahangir placed on a high point and center with a radiant halo around him, symbolising his ordained authority to rule. The Mughal court's global awareness and diplomatic relationships were seen through the representation of European figures.

C. Shah Jahan (r. 1628–1658): The Patron of Architectural Grandeur

Many people connect Shah Jahan's rule with monumental architecture, the very embodiment of which is the Taj Mahal. Nevertheless, he patronised the arts, which promoted symmetry, elegance, and opulence in miniature paintings. His illustrated chronicle of his period of rule, the Padshahnama, is a representative work of this aesthetic.

In The Shah Jahan receiving his sons and Asaf Khan, the emperor, in a formal durbar setup, appears in regal authority and composure. The painting denotes the hierarchic structure of the court, as well as the ceremonial nature of Shah Jahan's reign.

The painstaking labor involved in the opulent textiles and the architectural elements expresses the refinement of Shah Jahan's court and his acceptance of the material expression of imperial power.

These three emperors (Akbar, Jahangir, and Shah Jahan) had brought various contributions in the growth of Mughal miniature painting since the art was used as a podium to express individual ideologies and the materialization of their authority. In their patronage they built a visual culture heritage of their reigns that did not only record their reigns but projected their imperial identities to contemporaries and generations yet unborn.

Figure 3. Shah Jahan Receiving His Sons and Asaf Khan.[3]

III. Visual Strategies of Imperial Identity

Mughal miniature painting is not simply an expression of beauty, but is a conscious rhetoric of an image of an empire – an art that establishes, maintains and authenticates the power of empire. During the judgments of Akbar, Jahangir and Shah Jahan, emperors were visually portrayed superior to that of the mundane world inhabited by mortals.. By means of composition, symbolism, scale, and setting, these rulers were made into beings of divine approbation, cosmic equilibrium, and earthly sovereignty. While each emperor's approach to self-representation differed, they shared consistent visual strategies to ensure the empire's ideology of kingship was clearly and beautifully conveyed.

One of the most fundamental strategies was centralized composition. In nearly all major court paintings, the emperor is placed at the geometric center of the scene. This establishes him as the visual and symbolic axis of the world. In The Defeat of Hemu at the Second Battle of Panipat (Figure 1), from the Akbarnama, Akbar is centrally elevated on horseback, calmly leading his army amidst chaos. Though only thirteen at the time of the battle, the painting transforms him into a composed, divine warrior. His posture, placement, and size subtly imply that his victory is ordained—not merely won. Centrality, then, is not just about hierarchy, but about cosmic order: the emperor is the eye of the storm, the fixed point in a turbulent world.

Another visual strategy is the use of halos and radiance to indicate divine legitimacy. Mughal artists borrowed this motif from Christian and Persian traditions and applied it to rulers selectively. Jahangir, in particular, employed it consistently to suggest a connection with higher, spiritual realms. In Jahangir Preferring a Sufi Shaikh to Kings (Figure 2), the emperor is surrounded by a radiant halo formed by the sun and moon. This celestial backdrop elevates him above worldly leaders—like the Ottoman Sultan and King James I of England—who stand below him in order of spiritual importance. Jahangir's body language is also instructive: he receives a book from a Sufi saint, not a king, reinforcing the idea that his spiritual alignment is what legitimizes his worldly rule. Here, halos and posture act together to place the emperor above both time and politics.

The visual portrayal of ritual and ceremony also played a critical role. Under Shah Jahan, paintings took on a formal, almost theatrical quality. Shah Jahan Receiving His Sons and Asaf Khan (Figure 3), from the Padshahnama, is an exemplary court durbar scene where the emperor sits in perfect symmetry, dressed in pristine white robes, framed by elite courtiers and architecture that mirrors

the balance and order of his rule. The image does not present a casual or natural moment—it presents an ideal, sacred order. Everything about the setting—the textiles, carpets, arches, and attendants—reinforces the idea that the emperor is the calm, eternal center of the Mughal universe. The formality and repetition in these court scenes communicate stability and divine favor. They aren't just pictures of events; they're visual affirmations of the emperor's unshakable place in the world.

Color and ornamentation further reinforce imperial identity. Rich reds, lapis blues, gold detailing, and white marble-like robes are not just aesthetic choices—they're symbols of wealth, control, and spiritual purity. In each of the three figures referenced, the emperor is robed more richly and lit more dramatically than any other figure in the frame. The use of gold or fine pigments around the emperor draws the eye toward him and elevates him beyond the human realm.

Together, these elements—central positioning, divine iconography, ceremonial staging, and chromatic emphasis—form a unified visual strategy that defines and defends the emperor's identity. Whether engaged in battle, symbolic preference, or formal audience, the emperor is never just a man. In the world of the Mughal miniature, he is the axis around which the empire—and indeed the cosmos—turns.

IV. Akbar – The Emperor as World Conqueror

Emperor Akbar (r. 1556–1605) stands as one of the most transformative figures in Mughal history, not only for his military conquests and administrative reforms but for his radical use of art to craft imperial identity. Under his rule, the Mughal miniature developed from a regional artistic tradition into a state-sponsored visual language of power. Instead of being mere decoration, painting became a political tool in Akbar's court—a tool used to unite his heterogeneous empire, to create his historical legacy, and an image of kingship based on justice, divine inspiration, and visionary leadership.

Coincidentally, Akbar's use of painting went parallel to the spectacular territorial growth of his empire and the official founding of the imperial workshop, or kitabkhana, at the close of the 16th century. This royal court studio connected Persian émigré painters, including Abd al-Samad and Mir Sayyid Ali, with Indian artists who received their education in the regional styles, such as Rajput and Jain painting. It produced a hybrid aesthetic that combined Persianate grace with Indian dynamism—bright colours, heroic scenes, and the expressive, individual faces. Akbar did not merely sponsor this innovation—he directed it. He reportedly kept artists working in teams, evaluated their progress regularly, and commissioned massive projects to chronicle his reign.

Nowhere is Akbar's visual strategy clearer than in the Akbarnama, the official chronicle of his reign authored by Abul Fazl and lavishly illustrated by dozens of painters. Among the most iconic images in this manuscript is The Defeat of Hemu at the Second Battle of Panipat (Figure 1). The image represents Akbar's first major military victory in 1556, when his forces defeated Hemu, a Hindu general leading a rival Afghan army. Though Akbar was only thirteen years old at the time and did not directly command troops, the painting reimagines him as the heroic center of the battle.

In the composition, Akbar is shown elevated on horseback, wielding a bow and wearing a saffron robe—calm and focused while chaos unfolds around him. His horse is rearing, symbolizing both energy and control. Behind him, Mughal forces advance, while Hemu's army is scattered in confusion.

Though the scene is crowded with action, all visual lines and energy direct the viewer back to Akbar. This central positioning—combined with the emperor's poise, clarity of dress, and compositional prominence—serves a specific purpose: to mythologize Akbar's leadership, projecting him as a preordained conqueror under divine protection.

Figure 1's significance lies in how it converts a historical event into visual propaganda. The image doesn't simply illustrate a moment; it transforms it into a foundational myth of Mughal authority. Akbar is not a boy-king thrust into war—he is a sovereign chosen by fate, commanding armies, guided by wisdom, and bringing order to a fractured world. This visual recasting of history reinforced his legitimacy, particularly among the empire's Hindu elites, many of whom may have sympathized with Hemu.

This was not a one-off strategy. In multiple Akbarnama illustrations, Akbar is portrayed as a conqueror who governs with compassion, consults religious leaders of all faiths, and builds cities (like Fatehpur Sikri) that symbolize pluralism and power. These images helped establish Akbar's ideology of Sulh-i-Kul (peace for all)—a political doctrine of religious tolerance and integration that was essential for ruling a diverse subcontinent.

Akbar's use of art to construct imperial identity was deeply modern. He understood that images could travel where words or armies could not. He used painting to narrate his story, display his strength, and advertise his vision of kingship across a sprawling and multiethnic empire. Through works like Figure 1, he presented himself not just as a conqueror, but as the unifier and moral compass of Hindustan. The visual vocabulary he created—central dominance, calm heroism, divine approval—would go on to shape how later emperors, including his son Jahangir and grandson Shah Jahan, portrayed themselves.

Akbar's art was empire-building in pigment and paper. Through it, he conquered not just land, but memory.

V. Jahangir – The Emperor as Cosmic and Refined

While Akbar established the foundations of Mughal visual statecraft through narrative and military imagery, his son Jahangir (r. 1605–1627) reimagined the imperial image with a new philosophical and aesthetic focus. A patron of the arts, a naturalist, and a connoisseur of symbolism, Jahangir steered the Mughal atelier away from historical epics and toward portraiture, allegory, and spiritual themes. His approach to imperial identity was not built on conquest or worldly dominance alone—it was deeply personal, cosmic, and moral. In his self-fashioned image, the emperor became not just a political ruler but the center of time, the cosmos, and divine justice.

Jahangir's reign coincided with relative political stability, allowing him the freedom to elevate the arts to new heights. He maintained and expanded the royal atelier, but with stricter quality control and a preference for meticulous naturalism, subtle modeling, and layered symbolism. Unlike his father, who celebrated the diversity of painterly hands working together, Jahangir preferred solo-authored masterpieces. He commissioned not only depictions of himself but also flora, fauna, and allegorical scenes that reflected his personality and worldview.

The best-known image capturing Jahangir's unique visual strategy is Jahangir Preferring a Sufi Shaikh to Kings (Figure 2), painted by the artist Bichitr between 1615 and 1618. This painting encapsulates Jahangir's self-image as a morally and spiritually superior monarch whose legitimacy is rooted not just in lineage or force, but in divine alignment. It is not merely a portrait—it is a visual manifesto.

In the composition, Jahangir sits on an hourglass throne, elevated above four figures lined in descending importance. He hands a book—a symbol of knowledge and spiritual authority—not to a fellow king, but to a Sufi shaikh. Below the shaikh stand the Ottoman Sultan, King James I of England, and Bichitr, the painter himself. This visual hierarchy is radical: the world's most powerful monarchs are literally beneath Jahangir, both spatially and morally. By placing himself above all worldly power, Jahangir makes a clear claim—that his authority is not dependent on political alliances, but on spiritual superiority.

The background deepens this message. Jahangir is framed by a golden halo formed by the sun and moon—symbols of time and cosmic rule—suggesting that his authority transcends the earthly realm. Angels hover above, inscribing the imperial narrative. The hourglass beneath the throne, through which sand flows, is inscribed with a line about Jahangir's reign being eternal despite the passage of time. Time, space, politics, and faith all converge around the emperor.

Every detail in Figure 2 reinforces Jahangir's self-conception as a divinely guided, morally elevated, and aesthetically refined ruler. His robes are delicately patterned, his posture is calm and composed, and his expression is serene but commanding. Unlike the dynamic physicality of Akbar's battle scenes, Jahangir's image is inward and metaphysical. He does not need to fight—he governs through wisdom, balance, and cosmic alignment.

However, the fact that King James I and the Ottoman Sultan are mentioned is also an expression of Jahangir's knowledge of world politics. Testing their subordinate status in the visual hierarchy, Jahangir claims Mughal dominance in the larger world system – not through battles, but through spiritual and artistic sophistication. His court was involved in interacting with Jesuit missionaries, exchanging European prints and subsequent orders for hybrid artwork combining European techniques and Indian themes. What ensued was a Mughal cosmopolitanism, which was uniquely Mughal, whereby the emperor adopted and surpassed other cultures without losing his own power.

As a concluding sum, Jahangir's miniature paintings had nothing to do with conquest but with meaningfulness. In such a figure, as shown in Figure 2, he placed himself as a ruler with his power derived from divine vision, ethical choice, and aesthetic rule. The visual devices he employed – cosmic halos, hourglasses, allegorical layering – ensured that spectators did not only admire the emperor but identified him as a centre of a world organised morally.

VI. Shah Jahan – The Emperor as God's Shadow on Earth

During the reign of Shah Jahan (1628–1658), the Mughal visual language achieved an unprecedented level of polish, symmetry, and non-representational idiom. While Akbar's imagery highlighted narrative action and that of Jahangir – cosmic symbolism, Shah Jahan's court art depicted the emperor as a timeless and perfect representation of divine order. His self-image had nothing to do with human charisma or spiritual enlightenment but sacralised kingship - structured, serene, and unapproachable ideal. The emperor was a symbol of celestial geometry, of empire as harmony made apparent.

Often the reign of Shah Jahan is recalled because of the splendours of architecture – most notably the Taj Mahal – but his interest in painting expressed the same visual logic. symmetry, idealisation, and controlled elegance. The royal atelier during his time produced fewer narrative scenes and instead focused on highly stylized portraits and formal durbar paintings. These works were meticulously composed, using rigid hierarchies, refined color palettes, and repetitive motifs to present Shah Jahan not just as a ruler but as an icon of divinely sanctioned perfection.

This idealized vision of kingship is best captured in Shah Jahan Receiving His Sons and Asaf Khan (Figure 3), from the Padshahnama, the official chronicle of his reign. The painting portrays the emperor seated on a golden throne in full regalia, receiving his sons and Asaf Khan, a trusted noble and father-in-law. The composition is symmetrical to the point of rigidity: attendants and courtiers are evenly spaced, all facing inward toward Shah Jahan. Their deferential poses and secondary scale make it immediately clear who commands the scene.

What distinguishes this painting from earlier Mughal works is its stillness and formality. There is no dynamic movement, no narrative drama—only ceremony, control, and hierarchy. Shah Jahan appears calm, detached, and utterly composed. His white robes glint with gold thread work, not only signifying riches, but purity as well. His throne, which is set upon a carpet of complex geometric patterning, roots him as the visual and symbolic center of the empire. Even the architecture of his background—arched pavilions and marble balustrades–were symmetrical with his rule.

The depiction is not just an event – it is a philosophical statement. It portrays the emperor not as a creature of flesh but as the ideal emperor in an ideal world. This idea goes along with the Persian-Islamic ideal of the farr-i izadi (divine radiance), which regards kings as the terrestrial shadows of God's justice. Shah Jahan was frequently called Zill-e-Ilahi – "Shadow of God", and his likenesses supported that ideology. Figure 3 isn't just documenting some moment. It brings it to an eternal truth: that Shah Jahan does not rule by chance or by birth but by declaration of heavenly favour.

This turn to idealisation also represents a change in what Shah Jahan wanted to be remembered by. Contrary to Akbar, who favoured a dynamic and progressive face of leadership, and Jahanghir, who tried to present himself as a philosopher-king, Shah Jahan decided to be captured in the memory as a godly figure—outside politics and the realm of the act, removed from the time frame. His pictures are about perfection, rather than personality; distance, not intimacy; regularity, not spontaneity.

In the wider context of Mughal art, this change points to a high watermark in the visual abstraction of kingship. The realism or emotional depth is of no concern to figure 3; it deals with visual control. Not even the fabrics and jewellery are just being used for fashion – they help establish structure, repetition, and order. Because action is no longer necessary, Shah Jahan is not portrayed in action. His power, just like the construction of his court, is eternal, balanced, and inexorable.

So Shah Jahan's miniature paintings end the Mughal imperial imagery arc in this manner. From Akbar's heroic tale and Jahangir's cosmic self-reflection, we come upon Shah Jahan's divine icon. By such images as Figure 3, kingship itself becomes eternal — represented in ink, gold and perfect geometry.

VII. Mughal Painting as Political Propaganda

Mughal miniature painting was never purely about art—it was an instrument of politics. Beyond aesthetic innovation, these images served as active tools in the dissemination of imperial ideology. Carefully commissioned, meticulously crafted, and widely circulated, Mughal paintings functioned as visual propaganda that projected the emperor's authority across geography, religion, and

time. Whether depicting the emperor in battle, in celestial harmony, or in ceremonious stillness, these images communicated a consistent political message: the emperor is divinely chosen, morally superior, and the axis of order in a vast empire.

This propagandistic function is particularly evident in works like The Defeat of Hemu at the Second Battle of Panipat (Figure 1). Though based on a real historical event, the painting is not intended as neutral documentation. Akbar is portrayed at the moment of victory, radiating calm and composure, seated confidently atop a rearing horse while chaos unfolds around him. At just thirteen years old during the actual battle, Akbar's real role was limited—but in the painting, he is the central figure and the clear orchestrator of triumph. The image effectively rewrites history, transforming a boy-king into a chosen warrior-prophet. For the viewer, especially one within the empire, this representation reinforced Akbar's divine right to rule. For outsiders, it projected power, unity, and control. As part of the Akbarnama, the painting was copied and shared among nobles and dignitaries, becoming a tool of political storytelling.

A different kind of propaganda operates in Jahangir Preferring a Sufi Shaikh to Kings (Figure 2). This image is not about historical victory, but ideological hierarchy. Jahangir is shown bestowing his favor on a Sufi saint, while worldly kings—including the Ottoman Sultan and King James I of England—stand below in deference. Though they are powerful political figures, they are visually subordinated to Jahangir, who is haloed, elevated, and flanked by celestial symbolism. This composition sends a clear message to both domestic and foreign audiences: Jahangir's rule is grounded in spiritual virtue and cosmic alignment, not merely political force. The presence of Western figures in the painting—depicted with accuracy and nuance—demonstrates not flattery, but confident control. Jahangir absorbs their image into his own visual narrative, asserting cultural superiority while embracing global awareness. The image is a subtle yet potent example of soft power: through painting, Jahangir places himself at the top of a global moral order.

Under Shah Jahan, the tone of visual propaganda became even more formalized and abstract. In Shah Jahan Receiving His Sons and Asaf Khan (Figure 3), the emperor sits like a divine icon, flanked by courtiers and family in a symmetrical durbar scene. The painting lacks dramatic tension, yet it radiates authority. The lack of narrative action is intentional: Shah Jahan does not need to act; he merely needs to exist. His stillness, composure, and centered placement reinforce the idea that the empire is in a state of cosmic balance under his rule. The structure of the composition—the alignment of architectural elements, the arrangement of human figures, the mirroring of fabrics and jewels—visually confirms that the emperor is at the center of not just court life, but the very concept of order.

These images were not confined to court albums. Imperial portraits were often gifted to governors, foreign ambassadors, and loyal nobles. Albums of miniatures were diplomatic tools, political tokens, and even instruments of surveillance—ensuring that local rulers and administrators remained visually tethered to the central court. The Mughal atelier functioned much like a state propaganda office, producing standardized yet exquisite representations of power. Figures 1, 2, and 3—each from a different reign—show how flexible and effective painting was in serving imperial messaging.

Whether through historical mythmaking, moral allegory, or visual idealization, Mughal painting consistently functioned as a form of political communication. It shaped public

memory, instructed loyalty, and elevated the emperor above the realm of ordinary politics. In an empire that ruled through both vision and voice, miniature paintings gave form to the invisible machinery of power.

VIII. Conclusion

Mughal miniature painting was not simply a courtly art form—it was a visual apparatus of empire. Over the course of three reigns—those of Akbar, Jahangir, and Shah Jahan—the miniature evolved into a sophisticated tool of imperial image-making. Through color, composition, symbolism, and setting, these paintings crafted an enduring image of the emperor as not only a ruler, but as a cosmic, moral, and divinely chosen authority. The miniatures served as both mirrors and makers of kingship: they reflected the ideals of each emperor while simultaneously shaping how those rulers were perceived across the empire and beyond.

The Defeat of Hemu at the Second Battle of Panipat (Figure 1) reveals how visual storytelling was deployed to rewrite history in the service of power. Though Akbar was a young boy at the time of the battle, the painting casts him as a fearless and composed warrior, central and elevated amidst the chaos. This is not a mere record of a military encounter—it is the genesis myth of Mughal authority. Through such images, Akbar transformed himself from a tentative successor into a destined conqueror. These paintings were widely circulated, embedded in manuscripts like the Akbarnama, and designed to impress both nobles and the populace with a vision of imperial inevitability and divine sanction.

With Jahangir Preferring a Sufi Shaikh to Kings (Figure 2), we see a shift in the ideological use of imagery. Jahangir does not present himself through conquest but through spiritual alignment and moral hierarchy. By depicting himself giving preference to a saint over two of the most powerful kings of his time, Jahangir constructs a world where divine wisdom, not brute strength, legitimizes rule. The cosmological background—the merging of the sun and moon, the hourglass throne, and the celestial inscription—all deepen this portrayal. It is a masterful use of visual allegory as propaganda, asserting not only spiritual superiority but cultural refinement. Through this painting, Jahangir declares that the Mughal Empire does not merely participate in global politics—it transcends them.

Shah Jahan's Receiving His Sons and Asaf Khan (Figure 3) offers the most abstract vision of kingship. Here, the emperor becomes almost an icon—a still, radiant presence at the heart of a perfectly balanced world. The symmetry, the ornamental richness, the measured detachment—all serve to elevate Shah Jahan from man to myth. He is not portrayed as a military leader or philosopher, but as the embodiment of harmony and divine order. This image reflects the broader ideology of Shah Jahan's reign, during which architecture and ceremony were marshaled to express the timelessness and stability of the imperial order. In Figure 3, power is not asserted through movement or gesture—it is embedded in stillness, symmetry, and structure.

Across these three images and reigns, a progression becomes visible: from action to introspection to abstraction; from battlefield to cosmology to geometry. Each emperor adapted the visual tools of miniature painting to his own concept of rule, but all shared a belief in the necessity of image as power. These paintings were displayed, gifted, copied, and preserved not merely as art objects but as instruments of state. They created an imagined empire where the emperor was always present, always central, and always divine.

In the end, Mughal miniature painting stands as one of history's most effective systems of political image-making. It shaped the memory of emperors not through conquest alone, but through elegance, color, and symbol. Through Figures 1, 2, and 3, we witness how the Mughal emperors built not just armies and monuments—but visual empires. These paintings remain today not only as cultural artifacts but as enduring proofs of how art can shape reality, elevate power, and eternalize the presence of those who rule.

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The Research Divide For California Community Colleges

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In California community colleges, public policy refers to the state-level rules and funding decisions that actually dictate how schools operate.[1] In addition, institutional research is the process of collecting campus data to improve student success.[2] For all community colleges across California, these two things work together to shape everything from which classes are offered to how much support a student receives. As a major institution within this statewide system, Las Positas College is an important hub where these policies directly affect our student body.[3] While academic research is typically associated with four-year universities, such as the UC system, conducting research at the community college level is important, as it lays a foundation that prepares students for the rigorous coursework of a bachelor's degree.[4]

At Las Positas, students can access these opportunities through multiple pathways, which include the Honors Transfer Program, independent honors contracts, and campus-wide research events coordinated through RPIE.[5] While California's research policies are designed to ensure that every student has an equal shot at these experiences, there are still significant hurdles students must overcome. In practice, the goal of equitable access is often hampered by limited department funding, administrative restrictions, student time constraints, and a general lack of awareness of the resources available to students.[6]

To combat these structural barriers and get students into higher-level coursework faster, Assembly Bill 705 (AB 705) was enacted to ensure that students are admitted directly to their respective transfer-level English & Mathematics courses when possible.[7] The main purpose of this bill is to enable students to complete their studies more quickly by avoiding remedial classes. By doing so, this bill indirectly contributes to research engagement, as research opportunities are more accessible in higher-rigor courses. This policy aims to establish a fair environment by minimizing placement obstacles that have previously slowed or disadvantaged underrepresented students, thereby allowing them to move more efficiently into classes where academic and research skills are developed.

Assembly Bill 19 (AB 19), also known as the California College Promise, offers free education to full-time first-time students, thereby increasing the number of individuals able to participate in research. However, such bills do not fund research initiatives.[8] Equity is also achieved by this policy, as it removes financial barriers to higher education, allowing a wider, more diverse number of students to enroll in college and potentially access educational opportunities such as research.

Assembly Bill 1809 (AB 1809) focuses on improving data systems in California community colleges.[9] The bill aims to improve how community colleges in the state share and analyze data to support informed institutional decisions. This policy promotes more equitable circumstances by enhancing data transparency and accountability, enabling institutions to recognize disparities in student outcomes and develop strategies to improve access to academic support services, including research.

Comparatively, community colleges tend to have fewer research-designated programs and less grant funding than four-year colleges, such as the University of California system.[10] Research tends to be the guiding force that universities use to define themselves, as they secure research grants and stipends to support specialized student programs. Community colleges, on the other hand, tend to focus primarily on providing accessibility and transfer opportunities rather than allocating designated funds for such research.

Despite these funding constraints, community colleges still provide meaningful research opportunities. Community colleges tend to have fewer students per class than four-year colleges and universities. This allows for a higher teacher-to-student ratio and makes it easier for students to participate in research projects one-on-one with their faculty. Community colleges can also host research conferences for students at a lower cost or even for free, compared to those held by four-year colleges.[11] Additionally, community colleges can award honors designations to students, facilitating independent research. However, there are administrative and structural issues that might impede their full effectiveness, as seen in research opportunities, which are not necessarily dependent on such public policies but rather on the extent of institutional resources.[12]

Las Positas shows how a community college can turn abstract, research-driven policies into real opportunities for students by fostering a campus culture that ensures students feel supported and publicly recognized. The Honors Transfer Program at Las Positas allows highly motivated students to enhance their education and get involved in advanced honors-level coursework through designated Honors classes, embedded components, or by crafting contracts for regular classes to convert them into Honors classes. Through these opportunities, students work closely with faculty and are part of a supportive, academically rigorous community that prepares them for a successful transfer to four-year universities and beyond.[13] Students are also connected to multiple conferences – from the LPC Student Research Symposium available to all Honors students, to regional and national conferences such as the Bay Area Honors Research Symposium, HTCC's Building Bridges conference, and the National Honors Research Conference.[14]

Behind these opportunities, institutional frameworks play a critical role in supporting faculty and students' initiatives. According to Dr. Rajinder Samra, the Director of Research, Planning, and Institutional Effectiveness (RPIE) at Las Positas College, "support for students preparing to transfer to research-focused universities comes from both institutional infrastructure and direct academic programming." He explains that the RPIE office provides the "data, assessment, and analysis that inform college and department planning." At the same time, the Institutional Planning and Effectiveness Committee (IPEC) "helps translate that evidence into institution-level planning priorities." As Dr. Samra notes, while this foundational support is indirect, it is deeply meaningful in helping "the college identify where students are succeeding, where gaps remain, and where resources and strategy should be aligned."

However, to truly bridge the gap between the community college setting and the UC research community, broader systemic changes are necessary. Dr. Samra argues that the most impactful state policy to prepare students for research-oriented institutions would be to "provide dedicated, sustained funding for research opportunities at the community college level." He observes that community colleges are currently much better equipped and funded to support basic access, academic progression, and general transfer volume rather than "faculty-mentored research, students' stipends, summer research experiences, or formal research partnerships with universities." Dr. Samra advocates for a state funding policy that

targets “faculty reassigned time, student research stipends, and stronger transfer partnerships with UC campuses.” Such an investment would ensure that undergraduate research “is not limited to students who happen to find an opportunity, but instead becomes a more intentional and equitable part of transfer preparation.”

Las Positas shows that research-driven public policies are supported by campus facilities such as the Honors Transfer Program, RPIE, and IPEC.[13] Community colleges can go beyond the promises of equity written on paper to expand and support students in completing meaningful research. Bills such as AB 705 [7], AB 19 [8], and AB 1809 [9] allow transfer-level coursework, college access, and better institutional data. Still, it’s the daily work of faculty and honors contracts that turn these policies into real work. Through projects, presentations, and conferences, students gain academic confidence in areas where they might never have seen themselves as researchers.

Going forward, Las Positas can improve its impact by making research opportunities more visible in first-year courses, compensating students with small stipends or course release where possible, and using RPIE data to identify students who are underrepresented in current research opportunities within Las Positas.[15] Partnering with other California community colleges to share sample honors contracts and best practices for integrating research into regular classes would help spread this intended model statewide. Research at community colleges should no longer be an exception, but an expected part of an equitable higher education system.

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The Research Advantage

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California Community Colleges serve as essential gateways to higher education by offering accessible entry points for a highly diverse population, including first-generation, low-income, and underrepresented students. As inclusive institutions committed to equity and success, they support students in beginning their academic journeys and preparing for transfer to four-year universities.

ACCESSIBILITY

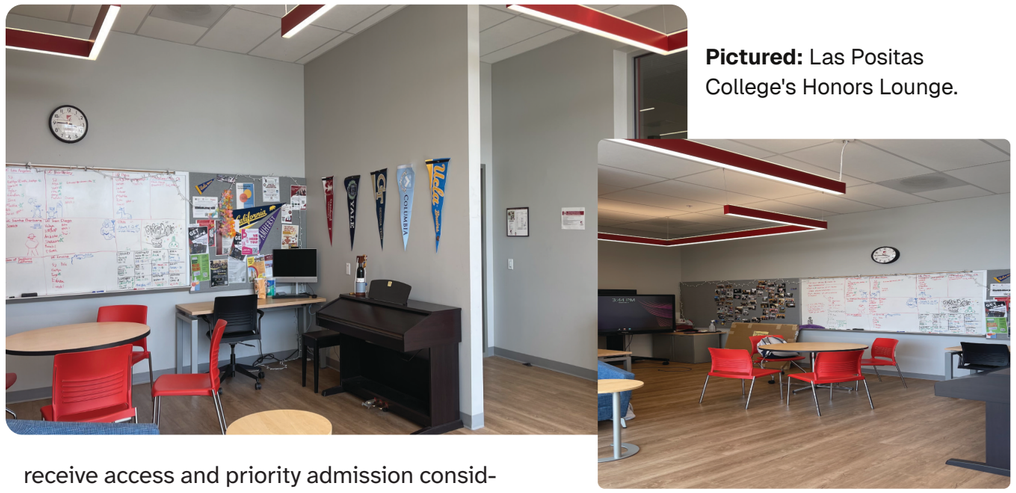
Students from low-income, underserved communities are able to achieve upward mobility through the accessibility of community college. For over 40% of U.S. undergraduates, community colleges serve as the entry point to higher education, especially those who are low-income, first-generation, and racial minority students (California Community Colleges Research Center, 2015). Transferring from community college generates strong economic returns to students and completing lower-division coursework at community college is less costly than completing it at a 4 year university and increases the number of students who will obtain a degree. At Las Positas College, the transfer rate of students is 46.67%, which is significantly higher than the statewide transfer rate of 37.93% (Las Positas Transfer Center). Las Positas gives students the resources they need to not only earn associate's degrees but to transfer to a four year university to complete their bachelor's degree through various transfer pathways.

IMPORTANCE FOR UNDERREPRESENTED STUDENTS

Community colleges tend to reflect the full diversity of the state's population as it serves as the primary access point for all students to start their journey to higher education (Jackson et al., 2023). However, the transfer rate is significantly low in California, especially for underrepresented students who do not have the same access to academic networks, institutional knowledge, or exposure to research. These students are more likely to experience imposter syndrome and self-doubt in academic environments. The study, "California Community Colleges: Designing mentoring for access to social capital," concluded that building one's social network is very important for college and career success (Balaraman et al., 2024). To give underrepresented students more confidence and increase their likelihood of transfer, community colleges such as Las Positas offer high quality research opportunities and mentoring from experienced faculty, which are the most effective ways to promote educational equity and strengthen student social networks (Balaraman et al., 2024). Las Positas helps these students gain confidence in their academic work and allows them to internalize the belief that they belong in academic spaces.

LAS POSITAS HONORS PROGRAM

LPC provides students with many opportunities that encourage independent learning and critical thinking skills that aid in student transfer and success in future upper division coursework. The Honors Transfer Program is specifically designed to give students opportunities to work with both faculty and peers in high quality research projects. Not only do students receive opportunities to expand their research and knowledge as well as work with experienced mentors, but they also



Pictured: Las Positas College's Honors Lounge.

receive access and priority admission consideration to various institutions connected to the Honors Program. The Honors Transfer Program at LPC aims to foster academic excellence, intellectual curiosity, and promote lifelong learning through a supportive learning environment for students from diverse and underrepresented communities.

PROFESSOR INPUT

Las Positas College professor and Honors faculty, Dr. Joanna Tice-Jen, explains that research opportunities at community colleges are especially transformative for underrepresented students because of the exposure to high quality academic work. For many community college students, especially those whose families don't have prior experience with higher education, these programs bridge the gap in academic access, knowledge, and networking. As the expectation for publication continues to shift to earlier stages across all academic disciplines, having research experience or published work can significantly strengthen transfer applications and expand future career opportunities. As stated by Dr Tice-Jen, research also teaches students how to navigate academic literature, distinguish it from general media, and engage with credible and well researched information at a higher academic level. Programs like the honors program at Las Positas allow students to access quality research, develop transferable research skills, and increase their educational and career mobility.

SUCCESS STORY: STEPHANIE MCMANUS

Stephanie McManus, LPC alumna and third year student at Columbia University, described the research opportunities available at Las Positas as a "game-changer" in the transfer process.

During her time at Las Positas, McManus completed multiple Honors projects within the political science discipline, allowing her to dive into niche research topics beyond the content of general education classes. Writing multiple Honors research papers, spanning 12-15 pages, further developed her argumentation, analysis, critical thinking and writing skills which have strengthened her academic confidence.

For McManus, the benefits of the Honors Program were especially significant as a first-

generation student without guidance or a roadmap. Community college itself felt "incredibly accessible," but she stressed that access alone isn't enough, students also need opportunities that show them how to succeed within the system. She explained that the Honors Program allowed for direction and support in the transfer process, aside from providing academic enrichment. The combination of strengthening academic skills, faculty mentorship, and guidance from the program were crucial for McManus when it came time to transfer.

The Honors Program also reinforced a deeper belief in the transformative power of education. She came to see that "education is the biggest factor" in increasing upward social mobility, particularly for students from underrepresented backgrounds who might not otherwise have access to these opportunities. Beyond the tangible academic benefits, the experience helped her recognize her own potential and reinforced that students from community colleges can excel in higher education.

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Arts Accessibility at Las Positas College

By Nika Karpelevitch
Senior Editor for Arts & Humanities

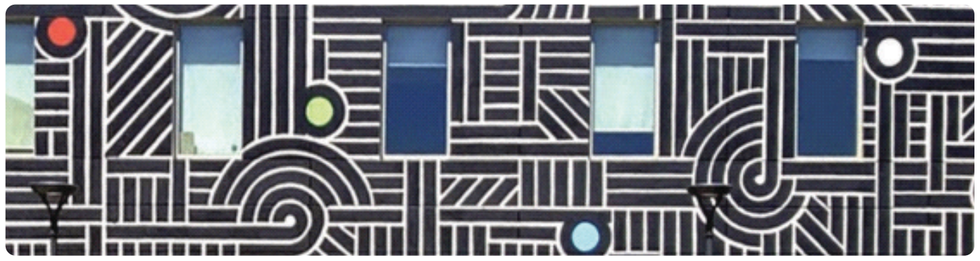

Figure 1. Aaron De La Cruz, Fruits of Labor (2021) from the collection of Las Positas College Campus Art Collection.

Arts-related opportunities and experiences help foster a more inclusive and engaging college experience. At Las Positas College, the arts are not limited to classroom lectures but extend across campus, providing students with more opportunities to develop their creativity, critical thinking, and artistic skills. Institutional support from CLPCCD policies, campus programs, and funding support arts initiatives aimed at supporting student success. These take the form of free events, publications, and honors research experiences. Taken together, these efforts expand access to creative opportunities and connect students to academic and professional development. This op-ed recognizes the value of the arts policies, programs, and funding at Las Positas College that increase student access to the arts through educational and career resources.

Las Positas has been actively facilitating increased access to the arts on campus since the formation of the Art on Campus Program, Committee, and Task Force in 2010. Utilizing the Nike Site Funds granted to the institution by CLPCCD in 2007, Art on Campus has been bridging opportunities for student artists and campus beautification for over a decade. In 2019, the Committee outlined a plan to prioritize local artists' and LPC students' artwork, increase cultural diversity and nature themes in on-campus artwork, engage all senses through the artwork, and plan for plaques and maintenance for existing pieces. In 2020 and 2021, the committee responded to the president's "Call to Action" by focusing on acquisitions from Black and African-American artists, aiming to promote diversity and increase their visibility. That same year, Art on Campus selected San Francisco-based artist Aaron De La Cruz to create the iconic geometric mural on the 1600 building, titled Fruits of Labor (see: Figure 1), which has become a beloved campus landmark. Currently, the Taskforce continues to acquire and display student pieces, such as alum Alexandra Faulkner's Thousand Cranes (see: Figure 2) linear sculpture installation in the 1000 building, among many others. On the Campus Art Collection website, 86 pieces and their artists, many of whom are LPC students and alums, are spotlighted. Moving forward, Art on Campus aims to further increase appreciation for the arts on campus by initiating virtual tours of the Art Collection and in-person art walks.

Art History faculty member Soraya Renteria, who has been part of the Art on Campus

Figure 2. Alexandra Faulkner, *Thousand Cranes* (2022) from the collection of Las Positas College Campus Art Collection.

Taskforce for several years, points to these efforts as part of a broader attempt to make the arts more visible and accessible. The placement of artwork in shared spaces throughout campus is intentional, she says, "so that all of our students have a chance to engage with art." Additionally, she shares that the short descriptions and online information accompanying each piece, as well as an interactive map tour, further deepen students' connection with the artwork.

Professor Renteria also sheds light on the efforts of her department to meet wider institutional priorities. She shares that the "focus district-wide to consider diversity, equity, and inclusion within our departments" has led to the significant expansion and diversification of Art History curricula, granting our students greater access to global art perspectives not available at other community colleges. Access, in this sense, goes beyond the classroom. For honors students especially, resources like library research databases, the campus gallery, and public art across campus often become important aspects of their research process. Altogether, these efforts reflect an ongoing initiative to improve inclusivity and accessibility to the visual arts for more students.

The unique literary arts opportunities offered by Las Positas are another affirmation of the institution's commitment to student success in the arts. What began as an idea shared over lunch with fellow faculty members Toby Bielawski and Richard Dry, recalls English Program Coordinator Martin Nash with a smile, eventually became the beloved annual literary arts festival at Las Positas. Featuring inspiring talks from a variety of authors, informative workshops, and a poetry-slam event, Professor Nash explains that the litfest is designed to "get students excited about the written word in ways that they probably wouldn't be otherwise." Now in its sixth year, this free event is made possible by the hard work of the fest faculty coordinators and the support of generous donors, including the City of Livermore, the Livermore Commission for the Arts, the LPC President's Speaker Series, and the Las Positas College Foundation.

As co-coordinator of the Havik literary arts journal alongside JAMS Program coordinator Melissa Korber, Professor Nash also shares the impact this publication has had on shaping student success; From granting students important networking opportunities at the Associated Collegiate Press Conference, where Havik has won 1st Place Best in Show four years in a row, to helping students develop strong practical, collaborative skills in journalism and beyond, the Havik has helped amplify countless creative voices at Las Positas since its founding in 1987, one of which has shared their own experience with the journal from a student perspective. Aaliyah Gholamipour, who currently serves as

an art and marketing mentor, tutor, and Havik advisor on campus, attributes their ongoing career success in large part to the guidance of JAMS faculty members Martin Nash and Melissa Korber, who, by opening doors to opportunity, Aaliyah claims, were “extremely helpful in my journey.”

On going global, Professor Nash explains that the Havik “hasn’t lost its local flavor,” through its continued celebration of LPC students and Bay Area artists, but that it “is also exposing people to international perspectives” by featuring submissions from creatives worldwide, making involvement in the journal an even more culturally and educationally enriching experience for students like Aaliyah to partake in.

The successful stories and experiences in the arts shared by students and faculty at Las Positas College reflect the importance of creative, financial, and mentorship resources in making them possible. Students have the opportunity to engage with the arts in various ways, including honors research, campus publications, public art programs, and even study abroad opportunities. These experiences extend beyond creative expression; they support students academically and prepare them for future careers, while ongoing efforts to improve accessibility and diversity in the arts aim to support our diverse student body. While public policies and funding lay an important foundation, the participation of faculty, coordinators, and students is what truly makes the arts thrive. At Las Positas College, the arts strengthen and brighten our community, contribute to long-term student success, and show the broader value of investing in arts education on our campus and beyond.

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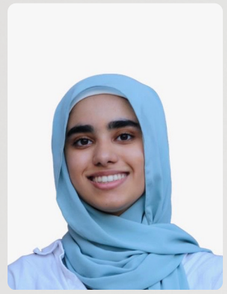

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