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Spring 2021
Dear Reader,

I write to you 1,047 miles from Yale within the confines of my childhood home, a situation I could not have imagined even a year ago when undergraduates were sent home indefinitely over spring break. The past academic year has been turbulent and rife with sorrow, globally and within the Yale community. The isolation of remote learning and distanced student life has been particularly trying.

And yet, we have persevered. Nationally, vaccines have been developed with unprecedented speed. More personally, this issue of the Yale Undergraduate Research Journal serves as a testament to the tenacity of our community and dedication to truth and excellence, even amidst a pandemic.

This past cycle, we received a record number of submissions—over 150 across diverse fields of research—representing a 50% increase from our inaugural issue. Correspondingly, we have more than doubled our staff to process submissions and worked with over 200 graduate student, postdoctoral fellow, and professor reviewers, whose thoughtful insight, expertise, and dedication to teaching serve as the bedrock of our journal. We have also begun a fruitful partnership with Symposia, a publication dedicated to profiling Yale’s undergraduate researchers, professors, and alumni.

Within the pages of this issue, you will find the strongest submissions we received in each division of the journal, an honor bestowed on only 6% of all submissions. The selected articles mirror many of the concerns of our current moment: the weight of social and historical forces, the crafting of resistance against these forces, the influence of moral attitudes in everyday language and political donations, and imminent considerations of climate change, computational methods, and aging. You will also find the winners of our inaugural cover design contest to the right, whose submissions were inspired by the abstracts of our selected articles.

In sum, I am delighted to share with you the spring issue of the Yale Undergraduate Research Journal. Over the coming months, we will continue to publish articles online of the many more excellent papers we received this cycle. As a preview, you may find the abstracts of these articles at the end of this journal.

We are endlessly grateful to have the generous support of Branford College, our advisory board of graduate students and faculty, alumni sponsors, and a number of Yale departments, supporting our journal through subscriptions and donations.

In pursuit of light and truth,

Selena Lee
Editor in Chief

For subscription inquiries, contact our business team at yura@yale.edu. Please include “YURJ subscription” in the subject line.

COVER DESIGN CONTEST

Artists within the Yale undergraduate community designed a cover inspired by the themes from one of four abstracts, selected from our spring issue. We are thrilled to present the winning submissions.

1ST PLACE | Cover Page

Laura Padilla, Art - Graphic Design, ‘22
My cover aims to tackle some of the abstract’s main arguments about performance in Edwardian childhood. The theater background alludes to the performative nature of Edwardian childhood as well as the class divisions in theatrical institutions during this period. This subtlety is reinforced by the child’s working class attire as well as his reluctance to meet the crowd’s gaze. The main feature of the cover is the child’s larger than life size which is meant to represent his separation from the audience and how his childhood itself is a means of entertainment as well as something seemingly fantastical.

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HONORABLE MENTIONS | Page 69
This essay explores, by way of visual and textual examples, the role of performance and fantasy in Edwardian childhood. The traditional imagery of childhood in the Victorian and into the Edwardian eras incorporates a connection to innocence and naivety through nature. In contrast, John Singer Sargent’s painting, Marionettes, revitalizes the viewer’s understanding of adolescence in the Edwardian era by reframing a puppet show to focus on the young puppeteer boys rather than the marionettes themselves. Further considerations, by way of Marionettes and related paintings, theatricality, and social performativity. Sargent’s painting also illuminates themes of sexuality and the freedom of emerging adolescence, which accentuates the divisions of class and gender in relation to this freedom, or the lack thereof. Moreover, each of these components centers on the function and necessity of performance and the social constraints on fantasy in Edwardian childhood, both in social self-presentation and educationally.

What is the role of humor in response to tragedy? Is it an appropriate expression of resilience after trauma, or does it undermine the gravity of suffering? However one may judge these questions, comedy has often emerged in reaction to tragedy throughout history. In modern South Africa, avant-garde artist William Kentridge and comedian Trevor Noah turn to humor to criticize the exaggerated rationality of apartheid and unite modern South African audiences in resistance. Connected in motive, William Kentridge’s absurdism and Trevor Noah’s comedy nevertheless give and take from one another in their distinct critiques of apartheid and post-apartheid society, approaches to historical reconciliation, and personal experiences with creative resistance. They demonstrate the intricacies of humor as a means of boldly stating the “unspeakable truths” of a nation’s violent past (Ashkenazi 94).

Unrest spurred by the resurgence of the Black Lives Matter movement in the United States has flowed throughout the city of Richmond, Virginia. Unique forms of protest have proliferated across the city, encompassing several artistic tactics such as graffiti art, oral storytelling, graphic design, and movement art. This paper will explore the effectiveness of art as protest by analyzing its impacts on several foundational aspects of social movements. Combining my personal observations, scholarly literature, and research on other social movements, I have developed my own findings regarding the use of art in Richmond’s Black Lives Matter movement. I posit that the use of art has functioned as an additive support to the movement rather than detracting from its success because of its pervasive nature across several foundational elements of movement-building.
The power of words we use to refer to one another is gaining recognition in contemporary socio-political discourse. Yet, interplay between language and complex cognitive processes, including moral judgments and identity formation, largely remains a subject of philosophical and theoretical debate. In order to begin examining the existence of such interactions empirically, this paper investigates the syntactic shift of the third person plural pronoun they/them to the third person singular, used to refer to gender non-binary/gender nonconforming individuals. Using grammaticality acceptance ratings and the Worthen 2016 moral attitudes test, administered under timed pressure, this study measures both intuitions surrounding the syntax of novel they/them pronoun usage and moral attitudes towards LGBTQ+ individuals. Analysis revealed a strong positive correlation between high grammaticality ratings of novel pronoun (they/them) usage and moral attitude scores. These results may be the basis for future investigation into a psycholinguistic connection between intuitive judgements of syntax and complex cognitive processes i.e., moral judgments.

Do religious donors give strategically or idealistically? The entanglement between the conservative Republican party and religious groups, particularly evangelical Christianity, on issues of abortion, sexual mores, and family values makes it difficult to analyze this question along voting lines. Regardless of how one votes, citizens and organizations can still punish their political leaders for moral infractions by voting with their wallets. This study aims to discern if there is a relationship between political scandals and religious donations.

Framework-based models serve as an important tool to describe, predict and manage ecological systems. In this paper I construct one such model, a dispersive force model based on MacArthur and Wilson’s (1963) theory of island biogeography, in order to assess island species richness with varying climatic patterns. Specifically, I use island–mainland distance (d), insular area (A), a climatic dispersal parameter (f), and a climatic disturbance parameter (h) to calculate the insular species richness ratio at equilibrium. To test this model through hurricane impact on marine islands, it was executed with data from islands of the Dutch Caribbean. Future climatic conditions were based on the UN IPCC report’s 2100 predictions with a mean global temperature rise of 2°C. Although the model was implemented with conservative estimates, all the islands tested show a significant decline in species diversity in future climatic conditions. The windward islands show a ~9% to 13% decrease in insular species richness, compared to ~2% decline on the leeward islands.

While prior studies have identified recurring genetic patterns, gaps of knowledge still remain in existing aging mechanisms; where they originate, and how they offer insight to environmental disruptions that dictate health over time. Given the inescapability of age-related deterioration and pathology, stitching together current literature may help demystify the biological process common to all living mammals. The physiological disruption of aged tissue reflects a cellular dependence on environmental cues and historical wear. Retaining the capacity to differentiate into any cell type, a stem cell best parallels a call-and-response relationship between organ and cell. As the longest living proliferative cell in multicellular organisms, stem cells respond to environmental cues through genomic or proteomic shifts. Aging tends to disrupt this capability, as stem cells lose functionality over time. This review will focus on the genetic mechanisms associated with stem cell depletion and skin tissue degeneration. By concentrating on genetic pathways common in studies comparing caloric restriction models in young and old species, this review will highlight commonalities that generate age-related stem cell depletion and tissue degeneration.
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Performance and Fantasy in Edwardian Childhood: Representations of Class, Gender, and Education

“The Seriousness of Play”: Humor as Resistance in Post-Apartheid South Africa

Tabula Rasa: Mechanism, Intelligence, and the Blank Slate in Computing and Urbanism
ABSTRACT

This essay explores, by way of visual and textual examples, the role of performance and fantasy in Edwardian childhood. The traditional imagery of childhood in the Victorian and into the Edwardian eras incorporates a connection to innocence and naivety through nature. In contrast, John Singer Sargent’s painting, Marionettes, revitalizes the viewer’s understanding of adolescence in the Edwardian era by reframing a puppet show to focus on the young puppeteer boys rather than the marionettes themselves. Further considerations, by way of Marionettes and related paintings, literature, film, and poetry, reflect on the concepts of representation, theatricality, and social performativity. Sargent’s painting also illuminates themes of sexuality and the freedom of emerging adolescence, which accentuates the divisions of class and gender in relation to this freedom, or the lack thereof. Moreover, each of these components centers on the function and necessity of performance and the social constraints on fantasy in Edwardian childhood, both in social self-presentation and educationally.

INTRODUCTION

John Singer Sargent’s Carnation, Lily, Lily, Rose (1885-86) presents a quintessential fin-de-siècle characterization of childhood (see fig. 1). Art at the end of the Victorian and into the Edwardian eras often illustrates children in idealized settings of nature, meant to emphasize their innocence and disconnect from the world of adult anxieties and responsibilities (Gallati, 110). In Carnation, Lily, Lily, Rose, two young girls stand in a vibrantly blooming garden in pristine, starched, and frilly white dresses that contrast with the untamed nature surrounding them and suggest a middle to upper-class standing. The combination of the seemingly-angelic dresses and the natural setting suggest a naive, soothing, and virtuous relationship between children and nature. The soft glow of the Japanese lanterns on the ground and in the girls’ hands and their resulting wonder accentuates their disconnect from the world beyond their safely-constructed and superficial environment, despite the scene’s obvious association with the openness of the landscape and the adolescent concept of freedom. Sargent forces the viewer to suppress their immediate association of the Japanese lanterns with international commerce or empire, conveying a feeling that the lanterns are natural by the banks of the upper Thames River in the Cotswolds. The balance between this natural feeling and an underlying sense of otherness in relation to the lanterns reinforces the childish naivety of the painting. In his 1903 painting, Marionettes, Sargent introduces the viewer to a revised visualization of Edwardian childhood, centering on themes of performance, functional fantasy, and the divides of gender and class (see fig. 2).

His painting breaks through the façade of social performativity and the idealization of universal experience that frame Edwardian perceptions of childhood and illustrates a distinctly working-class, gendered experience of children. This representation, in turn, both contrasts and complements diverging representations of adolescent life from the same period. The Edwardian period represents a time of intense social and political upheaval, and Sargent’s Marionettes reflects this self-conscious critique and evolution of established Victorian concepts. Through this painting, Sargent evokes questions of representation, theatricality, freedom, and sexuality.
However, because of the perspective, the performers’ bodies and the rods controlling the puppets become confused. Sargent adds to the layered and interconnected appearance by refusing to paint the rods connecting the boys and puppets with any kind of solidity; in fact, as the rods descend to the puppets, the line becomes a single, dry sweep of the brush. The obscurity of the line appears almost as though the connection is evaporating from the surface; evidence of reality—the rod—is giving way to the world of fantasy where the puppets simply mirror the actions of the boys as they create a fantastical narrative for the audience. The inconclusive nature of the presented show’s story and the relationship between the puppeteers and puppets accentuates the dynamism of the scene and the parallelism of the fantasy realm and the real world.

The illegibility of the painting’s narrative raises the question of the role of the artist in this period. It is not for the artist to make the narrative happen or construct the fantasy; it is for the boys to do so. Sargent draws attention to and reframes the narrative before him; he is both the revealer of the scene and the ideologue of this nuanced visualization of childhood performance. No visual, textual, or aural representation, not even film—which did not include sound at this point in time—can convey the exact lived experience of a performance. In Marionettes, Sargent illuminates a lost component of the performance, namely the young boy performers usually overlooked by the audience, by highlighting them with dramatic lighting, as though placing a spotlight on the working-class boys rather than the show they orchestrate below.

Sargent further distinguishes this portrayal from his other works involving children, usually commissioned portraits, through the size of the painting. At 29 by 20 7/8 inches, Marionettes signifies a small canvas for Sargent, indicating an intimate interaction between viewer and image. This size contrasts directly with Sargent’s monumental, opulent portraits for patrons; it also introduces the possibility of Sargent painting the image in situ, rather than in a studio like his larger works. Moreover, he retained the work in his personal collection throughout his life, only exhibiting the painting once in 1906 for the New English Art Club Summer Exhibition (Ormond, 56). This suggests the painting explores a personal or perhaps even experimental approach to the subject matter, more so than his many commissioned works. The painting depicts a marionette show Sargent witnessed in the “slums” of Philadelphia on a months-long visit to the United States (Ormond, 56). He conveys the atmosphere of the environment in his inclusion of the dingy and confining backstage area behind the vibrantly-painted backdrop of the stage.

Considering the origin of marionette shows in Sicily, the performers of this seemingly-neoclassical narrative could be Sicilian immigrants (Ormond, 57). Such an assumption asks the viewer to reconsider which figures Sargent manufactures as othered in the scene, and actually aligns the striking otherness of the neoclassical puppets with the puppeteer boys themselves, intensifying their social displacement. This possible identification of the boys as Sicilian immigrants also adds another dimension to the painting of performing one’s own culture for a foreign audience, not entirely dissimilar from Sargent’s own ex-patriate status in England. This cultural distance allows Sargent to act as a third-party critical observer in his works and often penetrates the social façades of
his sitters (Stephenson, 210). Despite the painting’s intimate size and his personal connection with it, the nuanced perspective suggests that Sargent maintained his ability to critically observe and reframe the social performativity he witnessed, even in his home country and culture.

The boys in the painting themselves reflect a sense of social performance and constructive fantasy as strongly as the physical performance of the puppetry. They create a world of fantasy for their audience, transporting them to a skirmish of soldiers many centuries in the past; they cannot just observe the marionettes for their own enjoyment. Sargent draws attention to the act of their performance to capture this image of the Edwardian mentality of performativity, as it relates to children specifically. These working-class children see behind the curtain of the fantasy, having to create it rather than purely consume it like the middle and upper-class children can on the other side of the stage. Those consumers cannot see or rather disregard the painting’s view of the boys hard at work with this older man aggressively instructing them, and the façade of the stage and backdrop giving way to the backstage area. The performing boys do not have the privilege of the “introspection associated with the adolescent state” by the Edwardian middle class (Gallati, 104). Their experience with fantasy is structured, regulated, and fully guided by their director in a way that destroys their own ability to freely fantasize for themselves; their disillusionment pairs with their need to perpetually create a sense of fantasy for others. This sacrifice of their fantasy realm comes not by choice but by necessity to provide for themselves and their families.

REPRESENTING GENDER AND CLASS

The function of fantasy for the working-class boys in Sargent’s Marionettes directly contrasts with the depiction of middle-class children engaging with fantasy in William Rothenstein’s In the Morning Room, 1905 (see fig. 3). Rothenstein’s painting, like Carnation, Lily, Lily, Rose, represents the idea of “a playful childhood masquerade,” which was central to the Edwardian concept of childhood identity and its associated innocence (Gallati, 109). His focus on the middle class does not exude the same level of opulent privilege evident in some of Sargent’s grandiose family portraits, like The Sitwell Family (1900), but these solidly middle-class families do not have the same anxieties as the working class (see fig. 4). In the Rothenstein painting, a young girl and boy stand with their mother in a carefully constructed interior of gender binaries and conveyors of social status.

The girl holds a doll, suggesting that her fantasy is mothering—a fantasy which has probably been urged upon her and encouraged by her parents and society. The evidence of this influence lingers through the mother holding the girl’s hand and gazing specifically down upon the girl rather than the boy as if approving of her daughter’s chosen performance of her not-so-fantastical future. Girls of the working class must mother younger siblings rather than imagining the experience with dolls. She is clearly associated with the decorative, floral curtains hanging behind her and the paralleled arrangement of flowers on the mantle, which draw the viewer’s attention to the massive landscape painting above the mantle. This landscape symbolizes the general association of children with nature, though the colors of the landscape painting reflect the colors in the prominent Native American headdress of the boy.

The boy possesses the most freedom of fantasy and self-conscious performance. He can dress up however he likes without any real repercussions because of both his gender and station. At the same time, the boy is clearly learning either directly or subconsciously about imperialism and popular culture through his choice of a Native American costume. The performance connotes relations to the American westward expansion of the previous decades, and the clear reference to the Lost Boys, who first appear in J. M. Barrie’s 1904 play and the subsequent 1911 novel, Peter and Wendy (Barrie). The allusion suggests a connection between the young girl and Barrie’s character Wendy, who—despite being a child herself—mothers the Lost Boys in the story. These same Lost Boys symbolize a sense of boyhood freedom and wilderness that Rothenstein’s boy embodies through his associated costume. He presents himself as though on stage in his costume, reminiscent of the Marionettes scene, except he knowingly places himself on view, while the puppeteer boys usually remain behind the obscuring surface of the curtain. Furthermore, the interior space connects the boy with the large bookcase behind the group of fig-
ures. Men must prove their worldliness, knowledge, and skills in order to become contributing members of the empire; the bookcase reflects this need to acquire such higher learning and respectability, mostly meant as a source of social performativity of their respectable education.

Rothenstein conveys that these middle-class children are provided with the tools and the freedom—though limited in the case of the girl—to create and live their own fantasies. They do not contribute to the family either economically or domestically like working-class children. The presence of the mother in the scene reinforces this separation between the middle-class children and the outside world, with her actively embracing and holding the children as though restraining them from straying too far from social and familial expectations. Rothenstein accentuates the performativity of children in society through the costuming and

Sargent’s Marionettes reveals to the viewer the same perspective Lily Bart encounters when—broke and judged for rumored affairs—her upper-class social circle rejects her in Edith Wharton’s 1905 novel, The House of Mirth, set in New York City. Sitting in a room surrounded by her former peers, Lily experiences “an odd sense of being behind the social tapestry, on the side where the threads were knotted and the loose ends hung” (Wharton, 291). She describes finding “amusement in the show” of the people’s behavior and interactions (Wharton, 291). Lily recognizes the performativity at the center of society in this period and reflects on the prescribed, superficial lives of those around her. Her ability to see behind the curtain and observe the ‘knotted threads’ and ‘loose ends’ of society, allows her to reflect on her role in the “great civic machine” (Wharton, 291). Similarly, Sargent reveals to the viewer the role of the boys in the marionette performance—their own position in the ‘great civic machine’ of society. Just as Lily sees ‘behind the social tapestry,’ Sargent brings the viewer “Behind the Curtain” of the show, which, appropriately, acted as the painting’s alternative title when presented in the 1906 New English Art Club Exhibition (Ormond, 56). The composition deliberately draws attention to the deception of the performance through the framing of the scene, but also the appearance of an off-stage performer or observer glancing around the edge of the backdrop from backstage.

The man on the far right of the scene observes the dual performance of the puppeteers and puppets, yet he fixes on the marionettes and not the boys, similar to a traditional audience. He acts as a commentary on the blindness of most viewers who do not consider the real performance occurring behind the curtain, only the fantastical presentation in front. The mysterious man watches the puppet show intently, adding drama and suspense to the scene, and offers a strange parallel with the male puppet facing the viewer. The observing man exactly reflects the soldier puppet’s visage through a similar tilt to their heads, similarly shaped headgear, thick eyebrows, dark eyes over a large nose, and a drooping black moustache. The seemingly impassive or anticipatory expression on both of their faces completes the juxtaposition and raises the question—does Sargent suggest through the comparison that the performance is reflecting real life or that life reflects the performance? Or, perhaps Sargent indicates that the two are one and the same in his own modern world of idealized social facades and the employment of fantasy in childrearing practices. In a time of such explosive advancement and social, political, and economic upheaval, the turbulence of the constantly-evolving Edwardian culture manifests itself in this uncertainty of distinction between illusion and reality.

In his poem, “If—,” Rudyard Kipling acknowledges similar concepts of necessary performance in real-life situations through a call for self-control and self-awareness of young boys in order to achieve success and manliness. He reflects on all of the binaries, or contrasting ends of various social and personal spectra, that define a man’s position in society. This direct reference to opposing pairs of concepts contemplates the more general theme of the Edwardian era as a period of dualities—tradition and social upheaval, nostalgia for the past and present moment versus anticipation for the future, calm contentment and political unrest. Kipling references fantasy throughout the poem, both obliquely and directly:

Figure 4. John Singer Sargent. The Sitwell Family. 1900. Private Collection.
He clearly conveys the importance of fantasy and ‘dreams’ in childhood learning and development, but only up to a point before they impair one’s ability to remain rational in manhood. Kipling also references the necessity of performance and façade in order to maintain and protect one’s true identity and ‘virtue’ in all social situations. A self-conscious performativity is crucial to success as a man; one should not “look too good, nor talk too wise” or risk straying too far from the social status quo (Kipling, line 8). Level-headedness and creativity that does not surpass the expectations of decorum lead to the ultimate achievement of social and personal success, according to Kipling. He critiques the idea of boyhood as an age for physical liberty and freedom, recognizing its virtues in the development process, but the necessity of its careful restraint and ultimate restriction in order to conform to the expectations of the Edwardian social order.

EMERGENT ADOLESCENCE AND SEXUALITY

In Marionettes, Sargent similarly reflects on concepts of boyish physicality and freedom through the physical space he constructs and his embodiment of sexuality and interpersonal tension in the figures. The puppeteers’ performance necessitates a position so high up in the space that their heads almost reach the ceiling. The shadow of the older man’s head on the ceiling above him nearly touches his hair, signaling the confining environment in which Sargent depicts them. The composition almost imagines the figures are sitting in the ‘gods’ of a music hall watching their own performance, while also recognizing them as gods of the scene, manipulating the puppets on the stage below. The warm, dramatic glow of the lighting illustrates the heat of the space, especially up in the rafters of the building. The space itself, both physically and atmospherically, oppresses the burgeoning physicality and boyhood freedom of the young performers.

Illustrating the sweltering environment, the boy closest to the viewer and commanding the most space in the scene has removed his shirt, and the sleeves of the other boys’ shirts are rolled up, exposing their forearms. The combination of the heat, the labor of their performance, and the palpable sense of tension in the space between the boys and their director hints at a sense of “sexual awakening” (Gallati, 110). The boys, especially in their interaction with the older, authoritative man inserted between them signals a similar, though subtler, “fetishization of male sexuality” to many of his male portraits, like his garish, red-obsessed, theatrical portrait of Dr. Samuel Jean Pozzi at Home (1881) (see fig. 5) (Stephenson, 212).

As in Dr. Samuel Jean Pozzi, the scene in Marionettes conveys a sense of eroticism through the intense physicality and dramatic mannerisms of the figures (Stephenson, 212). The homoeroticism emerges most strongly through the juxtaposition of the semi-nude young boy and the older, fully-dressed man looming over the trio, accentuating the restrictive space and exacerbating the tension of the contrast in their portrayals and the protruding limbs of the boys. Even the loose, tactile way in which Sargent paints the shirtless boy’s protruding arm and torso demonstrates a distinct physicality, dynamism, and fleshliness in his representation.

Indicating a direct contrast with this sexuality-focused aspect of Sargent’s subversive presentation of Edwardian childhood, the universal image of the child in Edwardian society promoted a necessary shielding from “adult knowledge” like economic concerns and sexuality (Davin, 52). This period also featured a distinct rise in anxiety about urban children’s health, which directly correlated with worries about England’s imperial and economic future (Davin, 53). As a result, along with the implementation of mandatory schooling, education came to include physical improvement...
through exercises called ‘physical jerks.’ This educational and societal evolution of childhood development manifests in Sagar Mitchell and James Kenyon’s film of children doing airplane exercises at Audley Range School in Blackburn (ca. 1904) (Mitchell and Kenyon). In Marionettes, Sargent counters this view of working-class children as ill, unhealthy, and weak; in fact, the three young boys appear quite strong and healthy, possibly as a result of their intense labor.

The ‘physical jerks’ exemplified in the film aimed to prepare boys for becoming soldiers and address the general anxieties about the urban world degenerating the human body, especially that of the working class (Davin, 53). Upon a first viewing, the video clearly illustrates the employment of fantasy, even in schoolroom education. The children pretend to fly like an airplane or Peter Pan; the teachers encourage the children, for the purpose of exercise, to imagine they are someone or something else. The routine, orchestrated manner of the continuous rounds suggests a learned performativity of the airplane and other exercises. Additionally, through the subtle or overt glances of children toward the camera, they know someone is filming them, which adds another layer of self-conscious performance to their actions.

Upon closer analysis, the gendered distinctions and limitations of the exercises become clear. The boys bend at the waist and reach their arms over their heads; their movements convey a feeling of freedom and explosive action. Meanwhile, the girls’ exercises only require that they hold their arms out straight from their bodies and bend them at the elbow—they reflect a clear restriction of movement. Even in these schoolyard exercises, the sense of educational fantasy for girls is limited. Boys can roam free and hold complete control over their fantasy worlds, but social expectation still confines girls even within that constructed fantasy.

CONCLUSION

This clear distinction between genders calls attention to one of the most defining aspects of Sargent’s Marionettes, in consideration of representing the purpose and function of fantasy in Edwardian childhood. The image presents a distinctly gendered scene. The youngest boy farthest from the viewer controls the only female puppet, suggesting a hierarchy among the puppeteers, with the manly, fighting roles preferred. Furthermore, the only female figure in the scene is the female puppet itself. While the male puppets, presumably a Roman soldier by his distinctive, crested helmet and an adversary, engage in a theatrical battle, the young lady puppet in black stands motionless—the only truly static figure in the composition. This visual manifestation of the ‘damsel in distress’ perpetuates the limitation of fantasy in the minds of many girls watching the performance to a strictly inactive and helpless role in society while the male marionettes and the boys manipulating them engage in an intensely physical act just in front of her.

This lack of female representation in a working-class setting contrasts with Sargent’s Carnation, Lily, Lily, Rose, which emphasizes the naïve charm of young girls in Edwardian culture, as seen in Rothenstein’s painting, but also centers on their proper, middle-class dress and natural environment, outside of which their very representation becomes sidelined, as in Marionettes. While Edwardian culture historically reflects a universal “middle-class ideal” of childhood, lessening the distinctions between class and gender to some degree, Sargent’s Marionettes highlights the multifarious nature of children’s experiences at the time (Davin, 62).

Rothenstein’s In the Morning Room, Sargent’s Carnation, Lily, Lily, Rose, and Kipling’s “If—” convey a distinctly middle-class, innocent, and structured representation of childhood. They each illustrate the social norms of children and unobtrusively reflect the differences between gendered expectations in respectable society. Rather than obscuring the demarcations between these ‘Edwardian childhoods,’ Sargent illuminates the class and gender divides in Marionettes. He reframes these divisions to illustrate the necessity of performativity and the central role of fantasy in the lives of the Edwardian child; he opens the viewer’s eyes to a multi-faceted, layered understanding of the child’s experience in Edwardian society. The Mitchell and Kenyon film further indicates the variety of experience as it relates to education and gender in the Edwardian school system, illustrating the functional implementation of fantasy, but also evidencing the distinction between male and female physical movement, or the lack thereof. Sargent additionally ruminates on the duality of childhood innocence and the inherent sexuality of emerging adolescence, adding to the kaleidoscopic representation. Similarly, Sargent presents a juxtaposition of burgeoning boyhood freedom and the limitations of children at the time, especially in relation to class, as he reflects on the contrast of the working-class boys to the nicely-dressed, adult director.

By approaching these themes through examples of paintings, literature, poetry, and film, the reframing of childhood in the Edwardian period and its various layers in Sargent’s Marionettes manifests itself with greater clarity. The multiplicity of media works to balance the drawbacks of each, giving words to the silent film, images to the texts and poetry, and movement to the still compositions. This balance of media and the consideration of class, gender, and education illuminate the implementation and practical function of performance and fantasy in Edwardian childhood, whether that function applies to physical education, work, family responsibilities, or general preparation for the child’s future in society.

ACKNOWLEDGMENTS

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For Amy DeLaBruere, the literary and visual arts are two branches of the same organism. Amy is a senior pursuing a double major in Art History and English who uses her study of English to better understand artworks and uses examples of visual arts when reading literature or studying poetry. She grew up making visual art in her small hometown in Northern Vermont where she also spent a lot of her time outdoors, running and hiking. As an artist, she enjoys black and white analog photography and printmaking the most. She believes that the darkroom is one of the most relaxing and meditative places you can find. However, as an art historian, she thinks that painting is often the most approachable art medium. One of the people who inspires DeLaBruere and her love for art is her mom, who is an artist and an art teacher. She encouraged her to convey her thoughts and feelings through art while growing up, and they would frequently visit museums as a family.

DeLaBruere’s love for reading has motivated her hobby of collecting old books, including first edition copies of her favorite books such as Edith Wharton’s *The House of Mirth* (1905) and Dorothea Lange’s *Ireland* (1996)–a collection of Dorothea Lange’s black and white photographs in the west of Ireland with an accompanying essay! Moreover, her favorite artist is Edward Hopper, but she also has a soft spot for the French Impressionists. In her first year at Yale, DeLaBruere began working at the reference library in the Yale Center for British Art where she became an expert in bibliographies while sifting the library’s resources to find references to specific paintings in the collection. She later became a gallery guide and a curatorial assistant in the prints and drawings department at the Yale University Art Gallery. On-campus, she serves as the managing editor for Asterisk*Journal for Art and Art History*, an art history journal based in New Haven, which provides an outlet for discourse around art for undergraduates. DeLaBruere’s favorite place on campus is the ancient gallery in the Yale University Art Gallery, which has a beautiful neo-gothic interior, massive ceiling windows, and a two-story-high ceiling that lets in light that beautifully illuminates the statues and mosaics.

In her research, DeLaBruere uses her background in the visual arts as a lens to look at Edwardian (1901-1910) childhood to explore the role that performance and fantasy play in it as a way to extrapolate gender roles and class divides. Inspired by a graduate-level history class she took on “Edwardian Modernity” with Professor Timothy Barringer, her research incorporates visual arts, music, and poetry as a means to look at history differently. Her practical and experimental exploration of art and her background with an artistic mother allow her to see art through both an analytic and creative perspective.

For the full-length profile, visit yalesymposia.com
“The Seriousness of Play”: Humor as Resistance in Post-Apartheid South Africa

By Ellie Burke¹, Professor Stephanie Newell²

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ABSTRACT

What is the role of humor in response to tragedy? Is it an appropriate expression of resilience after trauma, or does it undermine the gravity of suffering? However one may judge these questions, comedy has often emerged in reaction to tragedy throughout history. In modern South Africa, avant-garde artist William Kentridge and comedian Trevor Noah turn to humor to criticize the exaggerated rationality of apartheid and unite modern South African audiences in resistance. Connected in motive, William Kentridge’s absurdism and Trevor Noah’s comedy nevertheless give and take from one another in their distinct critiques of apartheid and post-apartheid society, approaches to historical reconciliation, and personal experiences with creative resistance. They demonstrate the intricacies of humor as a means of boldly stating the “unspeakable truths” of a nation’s violent past (Ashkenazi 94).

As Trevor Noah’s career-launching documentary, You Laugh But It’s True, reveals, “Comedy is about conflict” (0:42:04-0:42:22). While audiences can find it difficult to laugh at controversial or morbid jokes, turning to humor in the face of trauma is a common phenomenon. In “express[ing] forbidden ideas and deal[ing] with taboo topics,” comedy acts as a weapon of resistance toward oppressive systems by undermining their monopoly on discourse (Sørensen 8). Black South Africans “shift[ed]the debate about who play[ed]” during the apartheid regime in this way: as South African author Zakes Mda explains, “You laughed ... about how you outfoxed [the police] and then so on. Then it would be a big joke. Laughter was part of dealing with that situation” (qtd. in Sørensen 14; “An Interview with Zakes Mda”). In 20th century South Africa, comedy not only relieved the tensions of living in a racialized police state but also struck a blow to the self-proclaimed dominance of apartheid by laughing down the barrel of its gun.

Today, the legacy of subverting the authority of apartheid through humor lives on in the irreverent work of South African artist William Kentridge and comedian Trevor Noah. Turning to absurdity to criticize the exaggerated rationality of apartheid, Kentridge and Noah dismantle the regime’s foundations by turning its racism into farce. They only emphasize this critique by uniting diverse South African audiences in the shared mockery and analysis of their divisive past. However, they differentiate themselves with their unique personal philosophies toward play: while Kentridge’s absurdity indict apartheid and post-apartheid society from an ideological standpoint, Trevor Noah tackles institutional racism with the boisterous and stubborn optimism he learned growing up Coloured¹ in South Africa.

To begin, William Kentridge undermines apartheid’s harmful rationalism by employing absurdity as a “central point of construction” throughout his unconventional artwork (William Kentridge: Anything is Possible 0:40:57-0:41:42). Understand-
Although Trevor Noah does not address politics in the same dramatic manner as William Kentridge, his comedy similarly protests apartheid society by using his illegal existence to poke fun at its inherent flaws. As Noah writes about growing up as the Coloured child of a white man and Black woman in his autobiography *Born a Crime*, “Where most children are proof of their parents’ love, I was the proof of their criminality” (26). Casually quipping over his own conception, Noah employs a dark brand of humor to emphasize the failure of apartheid’s stringent miscegenation laws. His unlikely presence on the stage as a mixed comedian only echoes his life-long mockery of structural racism, for, like his parents’ relationship, his career “doesn’t merely challenge the system as unjust, [but] it reveals the system as unsustainable and incoherent” (21). Much as Kentridge points out the absurdity of apartheid, Noah uses the absurdity of his birth to make an equally damning critique of South African society. As a “taboo topic” himself, Trevor or Noah utilizes both his existence and his humor to ridicule apartheid’s authority on the post-apartheid stage (Sørensen 8).

Albeit in vastly different ways, Trevor Noah and William Kentridge further employ absurdity to confront the complacency of their audiences and urge them to engage with the consequences of their shared past. While Kentridge tries to absolve himself from reality through asserting that his job is “not to make sense” (*Anything is Possible* 0:00:44-0:00:51), his work nevertheless delivers a sharp judgement of post-apartheid society by demonstrating how the memories of systemic racism “will not easily fade” (Smith 52). Using reflection and other optical illusions, Kentridge holds up a mirror to his audience to reveal not only the absurdity of their racism but also the disguised reality of apartheid structures in post-apartheid life (*Anything is Possible* 0:21:23-0:21:35). Like his charcoal drawings, which are “partially rubbed out and re-emerges—transfigured—in a ceaseless flow of erasure and re-inscription,” Kentridge’s entire career underscores how the past bubbles beneath the surface of the present in South Africa (Dubow and Rosengarten 682). His work combats South Africans’ “willful amnesia” toward their crimes, providing a pathway toward reconciliation for audiences in the recognition of their collective palimpsest: a society that covers layers of racism and discrimination beneath a veneer of peace (*Anything is Possible* 0:11:28-0:12:06). Through his playful visual illusions, Kentridge confronts viewers with the agency they possess in interpreting the modern world in order to encourage them to question their own authority in preserving the lingering vestiges of apartheid (0:23:11-0:23:15). In this way, his resistance emerges not just on a grand political scale but also directs itself toward the individual complacency of each member of his audience.

If William Kentridge indicts the failures of post-apartheid society through his absurdism, Trevor Noah adopts a more optimistic view of South African reconciliation by striving to unite the country’s historically segregated population with his far-reaching life story and stand-up. As a polyglot Coloured man with a Swiss-German father and a Xhosa mother, Trevor Noah can relate to almost any audience member in a set. Such an “everyman” status naturally lends itself to the universality of comedy, as Noah reflects in his documentary: “You’ve lived everywhere and nowhere. You’ve been everyone and no one. So you can say everything and nothing” (*You Laugh* 0:00:43-0:00:53). An instant commercial success on the South African comedy scene, Noah’s story opposes apartheid’s legacy by providing a common point of connection for newly integrated audiences. He first witnessed the unifying power of comedy during his childhood, when his grandfather cracked a joke and made a white policeman cry with laughter during an anti-apartheid rally (“Growing Up in South Africa: Between the Scenes” 0:07:10-0:09:33). With an expressed desire to make his shows “just [about] human beings” rather than their race or class, Trevor follows in his grandfather’s footsteps to show a formerly divisive country that “when you laugh at the same things, you start to realize how much you actually share” (*You Laugh* 0:48:13-0:48:41). Far from being apolitical in his humor, Noah combats South Africans’ disregard toward the horrors—and hard-fought lessons—of apartheid by fighting to bring audiences together rather than letting them drift apart. In this manner, his comedy differs from William Kentridge’s absurdism in method but intersects in motive (1:13:14-1:13:23). Whether through intricate charcoal drawings or boisterous stand-up, Noah and Kentridge both encourage their audiences to resist the legacy of apartheid by confronting their amnesia and seeking points of commonality among themselves.

William Kentridge’s art and Trevor Noah’s comedy continue to connect yet diverge through their distinct personal philosophies in pursuing humor as a means of creative resistance. For William Kentridge, his upbringing as the son of Sir Sydney Kentridge and Felicia Geffen, two lawyers who rose to prominence for their defense of high-profile anti-apartheid activists like Nelson Mandela and Stephen Biko, irrevocably informs the content and technique of his artistry—albeit in completely opposite ways (“William Kentridge. . . ”; Smith 50). While his parents’ activism inspires the progressive subject matter of his political narratives, Kentridge expressly turns to art rather than law “as an important way of trying to arrive at an opinion [without] the rationalist form of legal argument” (*Anything is Possible* 0:51:42-0:51:51). He first discovered this avant-garde sensibility through repeated trips to “the gallery of [his] childhood,” the Johannesburg Art Gallery, when he was younger (“William Kentridge. . . ”). Kentridge’s parents also often hosted artist friends at the family home throughout his upbringing. In this way, Kentridge’s artwork stands as a complete embodiment of the influences of his past: while his content emerges from the “indignation and rage” he daily witnessed from his lawyer parents at the dinner table, his methods express the more bohemian styles of his family’s social circle (qtd. in “William Kentridge. . . ”).

Less than specifically evoking his own story throughout his artwork, however, Kentridge reveals the deeper truths he learned growing up in apartheid-era South Africa within his larger historical explorations. In response to his production

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2 The Xhosa are the second-largest ethnic group in South Africa after Zulu-speaking peoples. As one of the eleven official languages of the nation, seven million South Africans speak Xhosa as their primary language (“Xhosa”).
of Dmitri Shostakovich’s *The Nose*, an opera based on Nikolai Gogol’s 1836 satirical story by the same name, Kentridge comments that imperial Russia’s obsession with rank “rings a bell with anyone from South Africa” by echoing apartheid’s fixation with categorizing (*Anything is Possible* 0:40:57-0:41:42). The two most frequently recurring characters of his animation, the tycoon Soho Eckstein and the artist Felix Teitelbaum, similarly reflect the competing interests of apartheid life. Arriving to Kentridge in a dream, the two personas represent not only the battle against apartheid’s dehumanizing colonial industries, but also the forces at odds within the South African identity—and Kentridge’s personal history—throughout the 20th century (“William Kentridge, . .”). While it is imprudent to completely interpret Kentridge’s work through his life experiences, his rejection of rationalism and belief in the absurd as “an accurate and a productive way of understanding the world” nevertheless embed his specific brand of apartheid resistance—and his personal rejection of the law—in his globally-focused artwork (*Anything is Possible* 0:49:32-0:49:43). Within Kentridge’s philosophy of making the political personal, he understands the play born in reaction to his overly-rational childhood as one of the only effective modes of conveying the emotion of his and other countries’ traumas. 

Trevor Noah, in contrast, frequently employs shockingly personal humor about his upbringing in order to further the legacy of resistance he began at birth. Drawing on his entire life as a framing device for his punchlines, Noah’s collective and specific experiences under apartheid form the foundation of his comedy. So liberal is Noah in his discussions of trauma that the audience can experience whiplash at the startling disconnect between his subject matter and tone. In his autobiography, for instance, Noah continuously quips about the lengths he and his mother went to in order to avoid jail time: “I have dozens of pictures of me walking with [a] woman who looks like me but who isn’t my mother. And the Black woman standing behind us who looks like she’s photobombing the picture, that’s my mom” (28). While the reader finds themself laughing at the image of Patricia Noah, a famously fierce woman, hunching in the corner of Trevor’s childhood photographs, the reality of the line—that Noah and his mother could not even visit the park without fear of being arrested—is more grim than Trevor makes it out to be. From joking about not loving the pair of cats that his neighbors skinned and gutted out of suspicion that his mother was a witch (95), to riffing about the time his mom threw him out of a speeding minibus to escape being murdered by the driver, Noah constantly mixes trauma and comedy throughout his work (14-17).

However, the most striking experience Noah jokes about is his mother’s shooting. In his memoir as well as his stand-ups, he tells the story of waking up to a call that his mom had been shot in the head by her abusive ex-husband. Although Noah faced the unspoken possibility of losing his “teammate” while waiting in the surgery ward, he nevertheless cracks multiple jokes throughout his rendition of that day (274). In a gamut of emotional intensity only Noah can achieve, he reveals how he cried “as if every other thing I’d cried for . . . had been a waste of crying” on the way to the hospital, yet he laughs about giving pause when he learned his mother lacked medical aid (274). As he quips in reaction to the estimated bill for saving his mom’s life, “Well...what is she, fifty? That’s pretty good, right? She’s lived a good life” (278, italics his). In his stand-up, Noah adds even more to the absurdity of the scene by intimating how his younger brother continued to ask him when they could go home and play PlayStation while his mother was in surgery (“My Mom Got Shot in the Head” 0:04:38-0:06:20).

For all the bafflement of including these jokes in the greatest personal trauma of his life, Noah shows how he, too, learned his method of resistance from his parent. After waking up from her surgery to look into Trevor’s tear-streaked face, his mother urged him to look on the bright side of the shooting by teasing, “Now you’re officially the best-looking person in the family” (Noah 281). If William Kentridge’s anti-apartheid activism expresses itself as an absurdist response to his upbringing, Trevor Noah uses his own childhood lessons to reject racism by “choos[ing] to perceive things in a positive way even if they’re negative” (*You Laugh 1:10:53-1:11:12*). Refusing to let the inequality of apartheid break his comedic spirit, Noah honors his mother’s brand of resistance every time he ascends the stage to talk about his life: “That was my mom. Don’t fight the system. Mock the system” (Noah 251). In this way, Noah’s optimism stands as his own form of absurdism: growing up in a world that exploited rationality to discriminate against people like him and his mother, Noah denies his renderings of apartheid even a modicum of logic. Instead of reacting to injustice with cynicism, as one naturally would, Noah makes the absurd yet poignant decision to combat his struggles with laughter. For Noah and Kentridge both, absurdism and humor are unique expressions of their experiences growing up in opposition to the apartheid regime.

William Kentridge’s absurdism and Trevor Noah’s comedy emerge from the tragedy of their nation’s past to critically resist the legacy of apartheid in modern South Africa. While intersecting in motive, their styles give and take from one another in their distinct critiques of apartheid society, approaches to historical reconciliation, and personal experiences with creative resistance. Even with the subtleties between them, Kentridge and Noah nevertheless both embody the true role of humor in post-apartheid South Africa: representing the “unspeakable truths” of the country’s racism (Ashkenazi 94). “Encourag[ing] alternative interpretations of past injuries” in their irreverent works, the two artists force their audiences to confront the vestiges of apartheid rather than allowing them to feign amnesia toward the horror of their history (94). Through Kentridge’s palimpsests and Noah’s comedic interpretations of his own traumas, they navigate this “snail trail” of the past, refusing to remain either silent or complacent as South Africa reckons with its crimes (*Anything is Possible* 0:01:38-0:01:47). If fiction “encompass[es] the unsaid,” as South African writer Nadine Gordimer attests, then William Kentridge and Trevor Noah use humor to similarly denigrate apartheid a silent fate (“An Interview with Nadine Gordimer”). Resisting the unspoken in the boldest way possible, Noah and Kentridge underscore their nation’s fraught history in order to construct a better society through creative resistance. As Kentridge says of the role of
absurdism in modern South Africa, “The artist understands that both the optimistic and the pessimistic future unroll together” (Anything is Possible 0:51:27-0:51:31). South African humor is precisely that optimistic and pessimistic future.

REFERENCES


Ellie Burke is a charismatic first-year in Silliman College from Kansas City, Missouri. As a potential English or history major, she loves reading and writing, and is fascinated by both American and world history. In particular, she is inspired by people making thoughtful analyses of the past, bringing historical moments into contemporary resonance. This past fall semester, she enrolled in a first-year seminar on South African literature with Professor Stephanie Newell, culminating in an analytical research paper on humor as a subversive means of resistance in South Africa before and after apartheid. Having read the whole book of comedian and late-night host Trevor Noah’s memoir, Born A Crime, and having looked at artist William Kentridge’s mixed media and avant-garde and performative art pieces, Ellie discovered that humor and absurdity could be used in both subversive and yet dark and discombobulating ways to resist—but sometimes it was unsettling to laugh. Through this class, she also drew parallels between South Africa and the U.S.; the two countries learned from each other in their manifestations and institutionalization of racism and racist practices.

Throughout her research and writing process, Burke combed through databases like Articles+ and JSTOR, browsed Alexander Street, perused Trevor Noah’s reels, and watched the documentary You Laugh But It’s True, which describes Noah’s philosophy and outlook on life. Even over Zoom and at home in Missouri, Ellie was able to navigate the complexities of Yale’s library system, delving into questions of when it is appropriate to laugh, who truly has a monopoly on discourse, and how people fight the system by mocking the system.

Outside her major academic interests, Ellie is a board member of the Yale Drama Coalition, acting in and producing a wide variety of productions. She has also done some work for the Yale Historical Review, and she is a member of the Yale Undergraduate Prison Project (YUPP), working to provide accessible menstrual products to incarcerated women.

Some advice she would like to offer to first-year students and non-first-years alike is very much in line with what her first-year seminar professor told her: college students never need to reinvent the wheel with anything that they are doing, but should always be bold and critical in their analyses. Even when a student is unsure about something, just go for it. She also strongly encourages other students to browse and search for courses that they otherwise would never have the opportunity to take, and then enroll in that course no matter how daunting—alas, one only has 36 credits at Yale, so why not make every single one of them count?

For the full-length profile, visit yalesymposia.com
My work has a conversational relationship with the images the author provided, but neither the graphic nor typographic assets provided were incorporated into the piece. I was interested in the themes of cartographic legibility and illustrating emptiness with chaos, and the field of colors — convergent, overlaid, un-neat — evoke telemetry and other computational modeling/mapping of space and landscape, as well as the techne and human underneath these mechanic instruments. It is abstract expressionism mediated by a digital affect. I’ve thought of this visual approach as maximalism to describe minimalism in its negative, which touches on other concepts such as mediation, hierarchy, and legibility.

Based on the abstract from: “Tabula Rasa: Mechanism, Intelligence, and the Blank Slate in Computing and Urbanism”
ABSTRACT

This project critically examines the “tabula rasa” in computer science and urbanism, questioning the emptiness it describes in landscape through an exploration of its origins in terms of intelligence. Experimentation with tabula rasa in machine learning, where the term describes the originally empty knowledge base of a thinking machine, demonstrates the fallacy of a truly independent artificial intelligence and provides a critical lens through which to interpret the tabula rasa in urbanism. Revisited from this perspective, the case study of Hiroshima, Japan—an iconic example of the urban “blank slate” brought about through total demolition—can be read as a layered complex of historical and cultural components that, like a neural network, resist the separation of information and mechanism. The tabula rasa forms a theoretical conduit across computing and urbanism, enabling a novel transposition of the machine learning framework to cultural landscape analysis.

INTRODUCTION

Tabula rasa is a Latin term meaning “blank slate.” It means empty, razed, scorched, evacuated—but it also connotes wild, unbiased, and innocent. It means new birthplace and open opportunity, a materiality but all of which allude to the fond mythology of a completely new and innocent origin point.

This paper will investigate the tabula rasa across the fields of computing and urbanism, using the mechanistic revelations of machine learning experiments to drive observations of the tabula rasa in an urban landscape. It takes a field characterized by programmatic abstraction and immateriality and holds its approaches up to the light of an immediate, immersive, full-scale, and emotionally triggering landscape. It intends to illuminate not only the captivating instability of the tabula rasa in each context, but also the powerful potential of computational thinking as a framework for parsing the nuances of complex urban systems.

In computing, the tabula rasa describes the empty structure of an artificial intelligence capable of learning without any innate knowledge. It implies the miraculous production of understanding from a blank and formless mechanism. To demonstrate the artifice of this notion, I discuss a set of experiments that use an unsupervised machine learning model—an autoencoder—to interrogate an aspect of inbuilt bias or “knowledge” embedded in the neural network, demonstrating the insubstantiality of the computational tabula rasa by exposing the fundamental dependence of machine learning on innately ingrained information.

I translate insights from this experiment to the field of urbanism, where they inform an analysis of the tabula rasa produced by the atomic bomb in Hiroshima, Japan. Architecturally, the tabula rasa is conceptualized as the empty site: it describes unbuilt environments, or wilderness, but also sites that were once built and somehow razed by human violence or natural disaster. I pursue the traces of the erased in the reconstructed, demonstrating through the case study of Hiroshima’s Peace Memorial Boulevard that urban systems physically obliterated still exert an enduring influence through the culture of memory and the imperative of resilience.

My analysis of the tabula rasa in landscape is shaped by the intellectual framework of computational intelligence. I address the urban site with attention to the layered transformations of the neural network and interpret changes in the built environment as echoes of the mechanistic opacity and iterative clarity of a machine learning process. I metaphorically apply the procedures and mechanisms of machine learning to this analysis of the urbanist tabula rasa with the intention of introducing a new application of computational methods to the practice of urban studies, exploring a notion of the landscape as an intelligent machine. Through this novel critique of the tabula rasa, I reveal the utility of computational thinking for urban observation and explore the potential of a mechanistic approach to historical analysis.

ORIGINS: HISTORY AND THEORY

The tabula rasa denotes emptiness charged with potential. It is a latent intelligence, a promising void, a machine awaiting its ghost. It has made a long journey through various disciplines and movements in Western thought: the concept originated in philosophy, then wove through various notions of human nature to psychology, where its impact on theories of knowledge and learning brought it ultimately to computer science by way of artificial intelligence (AI).

The earliest ancestor of the computational blank slate appears in
Aristotle’s 350 BC treatise De Anima, where he philosophizes that “the mind is in a sense potentially whatever is thinkable, though actually it is nothing until it has thought,” (Book I) and compares this immaterial intelligence to the characters anticipated by a “writing-tablet” upon which nothing is written yet. This statement establishes the enduring cognitive metaphor of a promising empty vessel, awaiting the imminent but foreign intelligence that will inhabit it.

The tabula rasa later appears in the seminal “Essay Concerning Human Understanding” written by British political philosopher John Locke (1632-1704) in 1689 (Duschinsky 512). Locke’s adaptation of the metaphor, which renders Aristotle’s “writing-tablet” as a “white paper” (initiating the evolution of the tabula rasa according to changes in the technology of intellectualism), equates the empty page to the human mind at birth (Locke and Woolhouse 20). He envisions the infant consciousness as a formless intelligence, originally devoid of innate knowledge—or, therefore, any natural evil—that receives information and learns to process it purely by the inscription of sensory input (Pinker 5).

The Lockian tabula rasa informs the work of English cryptanalyst and mathematician Alan Turing (1912-1954), who is widely considered the father of theoretical computer science. Turing’s postwar writings on artificial intelligence are the founding manuscripts of the modern field, and it is through his work that the tabula rasa enters the computational vocabulary. In a 1950 issue of Mind, he wrote:

Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child’s? If this were then subjected to an appropriate course of education one would obtain the adult brain. Presumably the child brain is something like a notebook as one buys it from the stationer’s. Rather little mechanism, and lots of blank sheets. (Turing 19)

Turing carries forward the idea of the uneducated brain as a blank substrate and again updates the “white paper” to a “notebook” freshly purchased. Important in Turing’s notion of the tabula rasa is his distinction of mechanism from information: the empty and innocent consciousness he describes possesses no innate knowledge written across its pages, but it does require some minor mechanism to bind them together. Then, is the “tabula rasa” here the empty page or the notebook itself? An investigation of that question—of technically locating the computational tabula rasa—must pursue the distinction between information and mechanism.

**EXPERIMENT**

To empirically evaluate the computational tabula rasa, I conducted an experiment on my own machine learning model. I built a simple autoencoder to perform the task of reducing and reconstructing images of a handwritten zero and a handwritten one. I built the model properly and trained it successfully so that it was capable of reconstructing each type of image correctly. Then, I interrupted this learning by modifying an aspect of the original model I would classify as “innate knowledge” and demonstrating the effects of these modifications on the network’s ability to learn. The impairments brought on by my interventions demonstrate that even unsupervised learning relies on a certain quantity of inbuilt information.

The substrate of this process is the artificial neural network (neural net), a computing system vaguely inspired by the biological neural networks that make up the human brain. A neural net is composed

![Figure 1: The Aristotelian “writing-tablet,” technologically blank but anticipating its own inscription. Even naming it subverts this blankness.](image1)

![Figure 2: The neuron and the artificial neural network. The biological neuron is a type of cell that communicates with other cells via electrical impulse. The artificial neuron is a computational simulation of this behavior, using mathematical inputs and outputs to form a responsive network.](image2)
of artificial neurons that build up signals and “fire” when they reach a certain value threshold, similar to how their biological predecessors behave (Fig. 2). These neurons are connected to one another in multiple layers that apply different transformations to the data they take as input: as learning proceeds, the various “weights” that temper the outputs of each layer are modified until a functional composition is achieved.

The neural network described here is an autoencoder that conducts unsupervised learning. Its goal is to learn an encoding (an efficient data representation) for a given data distribution by filtering out all but the most defining features that differentiate data points from one another. This architecture is composed of an encoder, which compresses the input data to a dense and efficient encoding by a process of dimensionality reduction, and a decoder, which maps that encoding to a reconstruction of the original input. This reconstruction is typically a rough approximation of the original it references because the encoding process forces the network to focus exclusively on the most definitive aspects of the data it represents.

In this case, the encoder receives images 28 by 28 pixels wide, which the model reads as matrices of 784 numbers such that each image is a data point in 784 dimensions. The encoding is only two dimensions. Such stringent dimensionality reduction forces the autoencoder to capture exclusively the differentiating features of the data, and it also allows the learned encodings to be plotted on a Cartesian plane, which offers a compact visualization of the latent space in which the encoding operates. Figure 3 illustrates this process of dimensionality reduction and reconstruction in terms of the autoencoder architecture.

To investigate the computational tabula rasa through this autoencoder, I performed a set of experiments that expose the relationship between innate knowledge and functionality in machine learning. The experiments focus on the activation function: a mathematical entity that determines the firing threshold for artificial neurons.

In the brain, a neuron fires only when a sufficient electrical impulse builds up to provoke an action potential, which suddenly releases a charge down the neuron’s axon with enough intensity to transmit a signal to the surrounding cells. The activation function imitates this behavior, acting as a mathematical threshold that defines the range of input values forceful enough to elicit a “firing” output from an artificial neuron (Fig. 4).

My experiments demonstrate the importance of activation functions to the quality of the system’s training, evidenced in Figure 5. In a sequence of experiments starting with the original network (Trial 0) followed by two modifications to the activation function (Trials 1 and 2) and an iteration of the network trained with no activation function at all (Trial 3), the network’s functionality falter and disintegrates. As the clustering of data points in the autoencoder’s latent space (plots at left) loses clarity, the reconstructed images it outputs (right) become noisy, unfocused, and poorly differentiated.
These results indicate that avoiding such failure outputs requires not only the inclusion of an activation function, but the selection of the right one.

The activation function is assigned at the initialization of the network before any training data passes through it. In this way, it intervenes in the original Aristotelian “writing-tablet:” a blank surface

The methodological precedent for this interdisciplinary approach lies with the various architectural thinkers who have envisioned the city as an organism or machine—related metaphors that tend to bleed together. Two of the most famous architects to draw this parallel are Frank Lloyd Wright (1867-1959) and Le Corbusier (1887-1965), offer demonstrative examples. Wright combined the idea of the city as a biological system with specific attention to the mechanical nature of its organs and processes in his seminal essay “The Art and Craft of the Machine,” describing the city of Chicago as a mechanized life force:

There you may see how in the image of material man, at once his glory and his menace, is this thing we call a city… This wondrous tissue is knit and knit again and interknit with a nervous system, marvelously effective and complete, with delicate filaments for hearing and knowing the pulse of its own organism, acting intelligently upon the ligaments and tendons of motive impulse, and in it all is flowing the impelling electric fluid of man’s own life. (369)

Le Corbusier, whose work tended to “casually and without explanation treat the city alternately as organism and artifact,” famously summarized this metaphor in his image of an urban system as a “concrete biology” (Choay and Bratton 242). These descriptions of cities as both mechanical and biotic connect the theory of urban analysis to the parallel synthetic biology of the neural networks that carry out machine learning: through the metaphor of the intelligent mechanism, the city can be read as a sibling to the machine learning model, an alternative substrate for the biomimicry of artificial intelligence.
ARCHITECTURE

At 8:15 AM on August 6th, 1945, Hiroshima was illuminated by a noiseless flash from above (Hersey). Following that momentary flare, the city would make history as the first witness to the horrors of atomic warfare, suffering some of the most complete physical destruction ever inflicted on an urban landscape. Its reconstruction process after this devastating event represents not only an instance of total erasure and recovery, but also an opportunistic effort to revise the ethos of the urban environment. Hiroshima emerged from the blank slate of its post-atomic landscape with the objective of shedding the evidence of a long military past to become an International Peace Memorial City, as decreed by the Japanese government in 1949 (“Hiroshima for Global Peace” Plan Joint Project Executive Committee 8). The connotation of tabula rasa as “razed earth” makes Hiroshima the iconic example of the twentieth century empty site, given the unprecedented completeness of its physical obliteration.

Hiroshima recalls not only the destruction but also the aspirational history of tabula rasa planning. Its reconstruction strategy involved a fundamental rebranding effort to draw the culture of an International Peace Memorial City out of what was once a military-industrial stronghold (Hersey). This total overhaul of Hiroshima’s international brand required a nationally legislated reconstruction plan, which brought about the overt representation of the city’s new identity through law. The programmatic aspect of this development strategy opens an entry point for its interpretation in terms of artificial intelligence.

Hiroshima’s reconstruction began under the crushing and humiliating weight of American occupation and with the imperative to memorialize the tragedies of the war while developing an ethos for moving forward. Architect Rem Koolhaas’ Project Japan (2011) details the psychological trauma associated with Japan’s rapid retreat from imperial projects to reconstructive ones: “The same architects and planners who had, in the ‘30s, projected vast new settlements on wide open spaces abroad were now confronted with their own cities transformed into radioactive rubble. From utopia to apocalypse in less than half a generation…” (12).

To support this effort in the city most deeply associated with the nation’s wounds, the National Diet enacted the Hiroshima Peace Memorial City Construction Law in 1949. Its first article asserts that “Hiroshima is to be a Peace Memorial City symbolizing the human ideal of the sincere pursuit of genuine and lasting peace” (“Hiroshima for Global Peace” 12). The law goes on to detail specific strategies for constructing public peace memorial facilities on the same timeline as the basic infrastructure necessary to revive and inhabit Hiroshima, designating land for “Memorial Places” with the same urgency applied to roads and sewage systems. The commemorative structures still stand today as the primary landmarks of the city, which literally rebuilt itself around them as its defining features. The Peace Memorial Boulevard is one of these commemorative urban elements: a 100-meter-wide transect of linear parkland and several lanes of traffic cutting a horizontal swath through the city. This wide arterial corridor, flanked with rectangular stands of shade trees and memorial sculptures, gives the city its equator. It is a latitudinal landmark for Hiroshima, imbuing everyday navigation with awareness of the city’s tragic history and optimistic aspirations for the future.

One might expect that this version of monumentality through empty space arose from an instinct to preserve the flat, open plane of the atomic tabula rasa. But in this case, the wide swath of unbuilt space was already in progress before the bomb dropped. The 100-meter-wide gap in Hiroshima’s otherwise dense urban fabric actually began as a wartime technology: the space it created between the two halves of the city was planned as a firebreak, intended to protect each side from bomb-seeded fires on the other by imposing a gap in combustible material wide enough that flames could not reach across (Takezaki). This project was urgent and ongoing: at

Figure 6: The 100-meter-wide gap now known as the Peace Memorial Boulevard is visible in recent satellite images of Hiroshima (top: Google Earth) as well as in wartime photographs from before the atomic bomb (bottom: Photograph, US National Archives)

the time of the atomic bombing, there were crews of civilians, including young students, at work demolishing buildings in the path of the firebreak (Ibid).

The Peace Boulevard creates an idyllic frontage for Hiroshima’s Peace Memorial City messaging, but the reality that it predates the atomic tabula rasa, and that it was originally a defense apparatus rather than a peacemaking one, invites a closer look at its embodiment of that message. The Peace Boulevard’s urban form was initialized as a war apparatus and still under construction for that purpose when its entire context was destroyed by the atomic bomb. Then, when the city was reconstructed, the same form reemerged and retained its importance but took on a new meaning as a representation of peace. This process of reduction and reconstruction recalls the machine learning architecture that revealed the computational tabula rasa (Fig. 6).
In the autoencoder described earlier in this paper, the encoder reduces the dimensionality of the input data until it reaches a compact representation called the encoding, and the decoder gradually expands this encoding into an approximate reconstruction of the original input. Essentially, the decoder receives a very basic and condensed version of an idea and tries to imagine the full-scale original from which it was derived. The lower the dimensionality of the encoding—the less information it conveys—the less definite the decoder’s reconstruction of it will be.

The forced translation of the Peace Memorial Boulevard from a defense apparatus to a nonviolent monument evokes the imprecise reconstructions of a decoder working from a very small encoding. In my autoencoder, the input images were reduced from 784 dimensions to two, which resulted in reconstructions that only roughly captured the content of the originals. Envisioning the post-atomic wasteland as an encoding, in which almost every detail of the original city had been erased and only the barest suggestion of its former structure remained, invites a translation of the autoencoder framework to the process of post-war urban reconstruction.

Under this metaphorical concept transfer, the Peace Memorial Boulevard’s present articulation can be read as a reconstruction of its original concept based on the extremely reductive encoding of its post-atomic state. The reconstructed Boulevard is an alternative approximation of its military predecessor, distorted through the transformative gauntlet of the war. This reformation is effective: the Boulevard continues to perform its most basic role as a firebreak despite the layers of new messaging applied to its public appearance, and though the manicured promenade of the present day creates a very different atmosphere from the panicked civil-ian demolition project of wartime, the actual form that carries out this function remains the same. The drastic dimensionality reduction of the atomic bomb erased the details of aesthetic and political messaging, but the Peace Memorial Boulevard remains an accurate reconstruction of its wartime predecessor in that the most basic elements of its physical expression remain in place.

A reading of the Peace Memorial Boulevard as a skewed mathematical reconstruction of its former self illuminates the inertia of the city through the mechanism of the autoencoder. It reframes Hiroshima’s self-reinvention as more of a pivot, in which the same urban patterns were repurposed to represent new messaging without undergoing any fundamental structural changes. Just as the MNIST images lost certain details when they were compressed and reconstructed by the autoencoder, the firebreak’s wartime purpose was glossed over when it became the Peace Memorial Boulevard, but its original structure remained intact. This phenomenon can be traced to Turing’s original conflation of information and mechanism, where the computational information of data is translated to an architectural information of form: even when the form of the city was erased, its mechanism remained, and went on to reproduce the same forms as before.

**CONCLUSION**

This paper has explained the richness of the intelligent machine as an analytical framework, using a philosophical-experimental interrogation of the computational tabula rasa to inform an exploration of the urban blank slate.

Through machine learning experiments, I pursued the distinction between information and mechanism, looking for a way to isolate the computational tabula rasa as an instance of total blankness in my model. I found that even the simplest unsupervised learning architecture could not function correctly in the absence of the innate information represented by the correct activation function. In other words, its mechanism could not be separated from the information it was designed to output.

The shared concept of the tabula rasa provided a conduit for interdisciplinary conversation between computing and urbanism, allowing the transfer of the machine learning framework to my analysis of the Peace Memorial Boulevard in Hiroshima, Japan. In this instance of urban erasure and reconstruction, I transposed the insights from my autoencoder to read the landscape in a new way, comparing the different meanings of the 100 meter-wide transect before and after the war to original and reconstructed figures of image translation. Like my computational experiments, this encounter with the tabula rasa reveals the durability of structure and the mutability of detail.

In an essay about the entropic potential of overgrown sites of urban neglect, artist Flower Marie Lunn muses, “The spatial experience of a city is composed of multiple grids and cordoned areas, each with its abstracted boundaries. Striated space extraordinaire, a city is layers upon layers of structures and meaning—epistemological bureaucracies in concrete, if you will,” evoking the interlaced layers of a neural net as well as the methodical choreography of their interactions. My urban analysis takes a similar view of the city and pushes this concept even further, explicitly drawing on the idea of a programmed computational system that produces and manipulates information according to logical procedures.

However, the information, or “knowledge” that I ascribe to the city diverges from the mathematical data analysis of machine learning. I conceptualize it more as a collective or distributed version of the “tacit knowledge” originally formulated by Hungarian-British polymath and philosopher Michael Polanyi (1891-1976), rendered as architectural form. This type of information is acquired through practice and cannot be articulated clearly, having more in common with mental muscle memory or instinct than with explicit knowledge. I approach the city as a network of the woven quality Lunn describes, that produces a set of spatially-expressed habits akin to Polanyi’s tacit knowledge. This urban paradigm is both derivative of the neural network and an intelligent machine all its own.

The conclusion to this investigation requires the introduction of a final concept, which is the Computational Theory of Mind. It was this idea that originally defined cognition as a form of information processing, mobilizing insights from artificial intelligence research in the 1990s to expunge the tabula rasa from the field of psychology by connecting the fundamental molecular and electrical mechanisms of cognition to the intelligence they produce. It hypothesizes that rational thought can emerge from the combination of many instances of low-level logic synergistically networked to create the complex patterns that give rise to cognition (Pinker 32).

Pinker, referencing the Computational Theory of Mind, observes
that "the sister field of artificial intelligence is confirming that ordinary matter can perform feats that were supposedly performable by mental stuff alone" (33). This work falls into that sister field, demonstrating, through interrogations of information and mechanism in computing and urbanism, that the framework of learning is not limited to intelligence of any kind but can be applied to any system of networked logical components, visible or invisible. The city is one of these, but many more exist.

REFERENCES


ABOUT THE AUTHOR

Claire Gorman,
Ezra Stiles ‘20

by Rashel Chipi, Trumbull’24

Claire Gorman’s desire to test her education against theoretical questions landed her in Valdivia, Chile and Hiroshima, Japan for her research. Gorman’s research explores the notion of the “tabula rasa” or blank slate in both computer science and urbanism. The concept of a tabula rasa in computer science refers to a “thinking machine that’s able to learn, starting from nothing,” and in urbanism the tabula rasa refers to “represents an empty [physical] site.” Gorman visited Hiroshima, Japan, where an atomic bomb infamously razed the landscape into an urban tabula rasa in 1945. Gorman also visited Valdivia, Chile, which was “the site of the largest earthquake ever recorded” in 1960. The two sites gave Gorman a chance to explore “the concept of tabula rasa as a man-made erasure [in the case of Hiroshima] and as a natural erasure [in the case of Valdivia].” Gorman majored in Computing and the Arts, which combines computer science and architecture. Although the major offers no classes that combine both disciplines, students are able to find and explore “the theoretical crossover” of these disciplines on their own. The tabula rasa, a phrase that exists in both fields, gave Gorman an opportunity to do just that.

Although Gorman graduated in 2020, she was involved in many different extracurriculars during her time at Yale. Gorman was an involved leader in the First-year Outdoor Orientation Trips (FOOT) program and eventually spent a summer working for the Guadalupe Mountains National Park Service in Texas. Gorman was also the curriculum developer for Code Haven, “a student organization that visits New Haven public elementary schools weekly and teaches computer-programming principles.” Gorman also worked on a project in the Urban Ecology and Design Lab called the “ThermoGreen Wall,” where a vertical wet-land was constructed on the walls of buildings to explore their cooling effect on water. Since graduating, Gorman has joined the MIT Senseable City Lab as a research specialist.

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ABSTRACT

Unrest spurred by the resurgence of the Black Lives Matter movement in the United States has flowed throughout the city of Richmond, Virginia. Unique forms of protest have proliferated across the city, encompassing several artistic tactics such as graffiti art, oral storytelling, graphic design, and movement art. This paper will explore the effectiveness of art as protest by analyzing its impacts on several foundational aspects of social movements. Combining my personal observations, scholarly literature, and research on other social movements, I have developed my own findings regarding the use of art in Richmond’s Black Lives Matter movement. I posit that the use of art has functioned as an additive support to the movement rather than detracting from its success because of its pervasive nature across several foundational elements of movement-building.

INTRODUCTION

Since the resurgence of the Black Lives Matter (BLM) movement in Summer 2020, protests have spread rapidly across the United States. The movement regained momentum after the police murder of George Floyd, a Black man in Minneapolis (Hill, Tiefenthaler, Triebert, Jordan, Willis, Stein, 2020). This killing along with that of many other members of the Black community ignited large-scale protests amidst a dangerous pandemic. Thousands flooded the streets out of anger and impatience with a justice system that has failed their communities and taken away the lives of their loved ones. Home to a majority of Black and Brown residents (Richmond, VA | Data USA, n.d.), Richmond, Virginia is one of many cities that has proudly shown its support for the BLM movement.

While the COVID-19 pandemic pushed many protesters to restrict their activism to a purely online platform, others continued to express their grievances through different creative outlets such as graffiti art, music, and digital technology art. These alternative forms of protest that extend beyond traditional methods such as boycotts, sit-ins, and in-person demonstrations may hold some merit in the success of protests as opposed to or in collaboration with traditional methods. This paper explores the question of how the use of art as a protest strategy has shaped various elements of the Black Lives Matter movement in Richmond, Virginia. I was able to spend the Summer of 2020 in Richmond and to be witness to the explosive Black Lives Matter protests that took over the city. Thus, through a mix of my own observations, scholarly literature, and research on other social movements, I have developed my own findings regarding the use of art in Richmond’s Black Lives Matter movement. I posit that the use of art has functioned as an additive support to the movement rather than detracting from its success because of its pervasive nature across several foundational elements of movement-building.

FINDINGS AND ANALYSIS

Mission and Goals

At its core, the mission of the umbrella Black Lives Matter movement is to preserve Black lives by addressing police brutality, supporting Black communities, and dismantling systemic and institutional racism in an intersectional manner. In his dissertation titled, “Pictures Are Worth a Thousand Words: An Analysis of Visual Framing in Civil Rights and Black Lives Matter Protest Photography,” Marsh conducts an analysis of photography that compares the Black Lives Matter movement to the Civil Rights Movement. His depiction reveals that the work of activist photographers of the current BLM movement portrays an “unapologetically Black” version of the movement as opposed to the more passive Civil Rights Movement (Marsh, 2018, pp. 83–84). His work falls in line with the common assertion that the BLM movement has been a weak contender in the game of “respectability politics” as compared to the activists of the Civil Rights Movement who worked out of the Black church (Clayton, 2018). However, because the BLM mission is an intersectional one (Black Lives Matter, n.d.), the rejection of respectability politics in the powerful photography of BLM activists only lends support to the movement’s mission. In its push for respectability, the Civil Rights Movement, on the other hand, did not align with an intersectional mission as male and religious figures dominated the visuals of the movement (Clayton, 2018).

Marsh’s argument of BLM photography pursuing a more assertive strategy rings true in the case of Richmond this past summer. While still in support of the larger movement’s mission, the Richmond protestors also pushed for more local change as a part of their creative activism.
of their goals. Two of these goals were removing Confederate statues and addressing the lack of transparency in the Richmond Police Department. While several statues were removed (Schneider, 2020) and some progress was made to pass a Civilian Review Board that would increase police accountability in the city (Rockett & Suarez, 2020), the largest and most popular confederate statue of General Robert E. Lee remains standing in the newly named Marcus-David Peters Circle. Protestors have long sought to remove this statue, and their defiance has been depicted by photographer Christopher “Pumi” Smith whose artwork invokes the words of Marsh as revealing a more rebellious image of the BLM activists (Boot, 2020). Smith wants his photography to highlight the “demands” that Richmond protesters have for the local government as he places them in front of the Lee statue. This assertive goal stands in slight contrast to the relatively passive requests made by the activists of the Civil Rights Movement of documenting oppression; yet stands squarely aligned with the mission of the BLM movement as it was intended.

**Issue Framing**

While the protest outlet of photography served a helpful purpose in upholding the movement’s goals, artwork has also been shown to play a significant role in eliciting positive framing of the movement and creating new frames of knowledge-building. In contrast to mainstream newspapers that can demonstrate a more negative framing of the BLM movement (Marsh, 2018), Black media outlets and activists themselves can use creative outlets to construct a positive framing of the movement strong enough to attract more members. This was demonstrated in the city of Hong Kong where activists protested against the Chinese government by utilizing artistic work as “marketing tactics” and drawing global attention to their cause (Green, Patsiaouras, Veneti, 2018).

Similarly, activists in Richmond have been able to draw positive national attention to their own demands through the usage of the Lee monument as a site of reclamation. Not only is the statue now unrecognizable because of all of the artwork, slogans, and digital projections that cover it, but the circle that the statue sits in also now functions as a common area and safe space for all protesters and community members. Figure 1 shows the extent to which the monument was covered in graffiti and protest art. The wide range of colors, art styles, and images spray-painted onto the monument is reflective of only a fraction of the city’s artists. Viewing the chaotic scene of the monument with its overlapping images may overwhelm the spectator in a way that is symbolic of the anger and demands claimed by the city’s Black residents. It is argued to be one of the most influential spots of protest art since World War II because of this framing of protest as reclamation and transformation (Force, Hass, Lescaze, Miller, 2020). This powerful framing could not have been made possible without the imagery spurred by the protest art covering the circle. Thus, through this reframing of protest in the context of reclaiming spaces, protest artwork has functioned in a strongly beneficial manner in Richmond.

In addition to creating a positive framing of the movement, the use of art in protest can contribute to forming novel frames of knowledge around notions of collectivity and rebellion. In his dissertation titled “Rearticulating the Social: Spatial Practices, Collective Subjects, and Oaxaca’s Art of Protest,” Ivan Arenas explores the use of artwork in protests across Oaxaca, Mexico. He finds that Oaxacans were able to utilize artwork to build “alternative conceptions of ethical communities and a collective subject that bypasses state-based frameworks as the necessary horizon of Oaxaca’s future” (Arenas, 2011, p. 3). This framing of a collective as opposed to the isolation of the oppressed individual was pursued through collaborative forms of art-making and workshops.

Breaking apart the state-proposed frameworks and reimagining new visions of community-building have also been key strategies of the BLM movement. In her article, “Black Protest on the Streets: Visual Activism and the Aesthetic Politics of Black Lives Matter,” Nicole Schneider discusses the role of art and other visual protest practices in the movement. She demonstrates that “the artistic and aesthetic practices of protest and activism...use their artistic configuration to break through old and long-established frames of knowledge and recognition and present that which would have otherwise remained invisible” (Schneider, 2017, p. 23). More specifically, she points out several BLM installations, signs, and imagery that “make sense of the un/livable and the un/imaginable” (Schneider, 2017, p. 23). Similar to the Oaxacan rejection of state-based frameworks, through art, the BLM protests have been able to create new frames of knowledge and understanding around collectivity and abolition that may have been previously inconceivable.

Figure 1: This photograph of the Robert E. Lee monument was taken by me on August 1, 2020, as Black Lives Matter protests continued to spread throughout the city of Richmond, Virginia.
In Richmond, artwork was also pivotal to generating the emotional responses necessary for mass mobilization within the Black Lives Matter movement. For example, Terry Kilby is a digital artist who traveled to Richmond in order to capture the Lee statue that was covered in graffiti art. By using digital technology, he was able to capture and “immortalize” the statue, making it forever stand as the “beacon of hope” that he describes it as (Rodriguez, 2020). This emotion was captured through digital illustration, and even if the actual graffiti were to be removed from the statue, the digital element would remain and continue to elicit emotional responses from its viewers.

Digital art was also often on display as a projection on the Robert E. Lee statue in Marcus-David Peters Circle. Figure 2 depicts the image of Senator John Lewis projected onto the base of the statue, squarely underneath the “BLM” image projected on the general’s statue itself. Through the use of digital technology, artists were able to portray the real image of a powerful civil rights leader underneath the “Black Lives Matter” acronym. While the image of Senator Lewis is certainly a tribute to his monumental work during the Civil Rights Movement of the 1960s and early 70s, this positioning of his photo underneath the “BLM” image effectively creates a linkage between Senator Lewis’ historic civil rights advocacy and the modern movement for Black lives. The impact left by this image on its viewers is one of hope in the continuation of a freedom movement as people will continue to draw from the teachings of Senator Lewis far into the future.

In addition to digital art, movement art has also been present in Richmond. Two Black ballerinas who have gained national attention for their photograph in front of the Lee statue, illustrate the similarities that they have seen between dance and the movement (Curran, 2020). One of the ballerinas, Ava Holloway, explicitly cites the parallels “between the demands of the art form and the burden racism creates for people of color” and how dance, instead, makes her feel powerful (Rodriguez, 2020). Because of the unique but empowering emotions generated by the art form and by the photography used to capture it, this image stemming from Richmond was able to receive national attention and thus, was able to contribute to a broader mobilization of folks by making them feel connected to and join the movement.

**Formation of Collective Identity**

In Richmond, artwork was also pivotal to generating the emotional responses necessary for mass mobilization within the Black Lives Matter movement. For example, Terry Kilby is a digital artist who traveled to Richmond in order to capture the Lee statue that was covered in graffiti art. By using digital technology, he was able to capture and “immortalize” the statue, making it forever stand as Central to movement organizing is the building of a collective identity. Art as a protest strategy can contribute to developing this sense of common identity that is foundational to movement-building. There is no consensus on the definition of collective identity (Opp, 2009, Chapter 7); however, it has been shown to consist of members of a movement sharing an emotional attachment to the
cause and also to each other. Scholar Donatella della Porta argues that “social movements construct collective identities through the development of a common interpretation of reality. They construct frames about themselves and their enemies, and provide diagnosing and prognosis for social and political problems and solutions” (della Porta, 2018, p. 719). Ivan Arenas demonstrates how artwork lends itself to the “development of a common interpretation of reality” in the case of the Oaxacan residents who used artistic expression to foster “communal practices that gave rise to alternative models of human flourishing” (Arenas, 2011, p. 2).

By creating these new models of living that are rid of suffering, Oaxacans’ artistic collaboration effectively created bonds among their residents and developed a sense of commonality necessary to move forward with their movement against an oppressive government.

Scattered throughout the city of Richmond are beautiful murals painted by the city’s residents. One mural, created by artists Jowarnise and Ian Hess, depicted a Black woman alongside Marcus-David Peters, a man tragically killed by police during a mental health emergency in 2018 (WTVR, 2020). In an interview, Jowarnise described the symbolism in the piece as representing the “heritage, interconnectivity, and history of struggles and triumphs that have shaped our cultural identity” in order to help viewers understand their “shared history” and “to foster compassion and mutual validation” (Moreno, 2020). From this description, the notion of building and maintaining a collective identity is evident. By emphasizing shared struggles and histories, Richmond’s artists want to engage in a community-building rooted in mutual understanding. This collective purpose that flows through the artist works of Richmond’s protesters consequently contributes to the strength of the movement as a whole.

Institutionalization

Another factor critical to the long-lasting success of a movement is the institutionalization that follows a period of rapid mobilization. As argued by Mark and Paul Engler in their book This is an Uprising: How Nonviolent Revolt is shaping the Twenty-First Century, “when mass mobilizations, established organizations, and alternative communities see themselves as complementary, they can create a movement ecosystem that allows diverse approaches to promoting change to flourish” (Engler & Engler, 2016, p. 262). It is imperative that mass mobilizations such as that of Black Lives Matter rely on other organizing traditions in order to institutionalize and create permanent change. In fact, Emma Dorland argues in her dissertation, “Creative Nonviolent Action: Leveraging the Intersections of Art, Protest and Information and Communications Technology for Social Change,” that art and technology as protest can function as a method to make movements more durable in the long run. She specifically claims that “combining creative mediums, nonviolent direct action, and new technologies in social movements has the power to sustain broader public participation in the project of establishing social justice and peace today” (Dorland, 2015, p. ii). Thus, while the BLM movement is primarily recognized for its work on the ground, the multitude of artistic influences and technological usages deployed alongside that direct action can potentially lead to the institutionalization of the movement’s values of social justice.

I posit that the process of institutionalization for the BLM movement has already begun in Richmond in part due to the aid of creative outlets. As discussions about police accountability transpired across the city, the city council began exploring potential options to address the city residents’ grievances. Through the art of storytelling, these grievances could be clearly voiced. The American Civil Liberties Union (ACLU) of Virginia is one of the largest civil liberties organizations to be based in Richmond and also one of the largest platforms to voice the people’s opinions. For example, the ACLU was in collaboration with other local organizations to hold multiple town halls to address the issue of police brutality and the spread of COVID-19 in prisons.

A primary feature of these popular town halls were the stories told by the people directly impacted by the justice system, such as formerly incarcerated individuals. Storytelling as an art form was not only able to capture the attention of structural organizations in the region that consequently shifted their attention to the BLM movement, but was also able to captivate Virginian legislators and council members who held many sessions over the summer of 2020 to address these grievances. Thus, with the help of the local storytellers, Richmond organizations and politicians were able to digest the issues brought to light by the BLM movement and to work on materializing their demands into permanent fixtures (such as a police oversight board) and laws.

THE MISUSE OF PROTEST ART

In part due to the diverse forms of protest art created and displayed in the city of Richmond, many of the city’s residents have unified in allegiance to the Black Lives Matter movement and its mission. Although this paper focuses on the positive effects of protest art and its function in movement-building, there have been instances where artists and organizations have appropriated protest art for self-serving purposes that may detract from the movement. I believe that while these instances of performative and ill-meaning acts of artistic alliances do occur, they are not designed with the intent of serving as protest art, and consequently, do not reverse the positive effects of movement-building that typically sprout from protest art.

Some artists, associated with the Movement for Black Lives, have chosen to depict their artwork in exaggerated forms that romanticize the violence and hardship that Black people face. In her article, “Black Bodies, White Cubes: The Problem with Contemporary Art’s Appropriation of Race,” Taylor Renee Aldridge argues that “artists have made systemic racism look sexy; galleries have made it desirable for collectors” (Aldridge and Aldridge 2016). In an effort to popularize their artwork, artists may portray violence towards Black lives and destruction of Black lives in a way that diminishes their real impact in the world. However, artists who engage in this process are likely not creating artwork for the purpose of protest, but rather for the purpose of viewer satisfaction and consumption. While some of this artwork does unintentionally contribute to the larger goals of a movement, other pieces may not have the primary intent of advancing movement-building, but rather of obtaining viewer consumption. Artists may just want others to view their art, even if that entails misconstruing the
reality behind the art. Because of this differing purpose that does not fit within the broader movement’s mission, these pieces of artwork should not qualify as protest art, and thus, should not detract from the processes of movement-building that other intent-based protest art can illicit.

Similarly, artists and organizations may want their artwork consumed for reasons pertaining to financial profit. Aldridge describes her own apprehensions about some of the artists responding to the Black Lives Matter movement: “I wonder if artists… truly are concerned about black lives, or if they simply recognize the financial and critical benefits that go along with creating work around these subjects” (Aldridge and Aldridge 2016). Organizations also appear to be profiting off of artistic activism through their own means. For example, Katherine Timpf reported on the case of Urban Outfitters’ response to the Women’s Rights movement in her article, “Apparently, ‘Activist Appropriation’ Is a Thing Now” (Timpf, 2017). Urban Outfitters released a T-shirt with the slogan “burn your bra” on the front. By appropriating this symbol of the Women’s Rights movement and selling it for profit, Urban Outfitters also appears to be misconstruing the goals of the movement by selling its symbols for corporate gain. In these instances, despite drawing attention to the movement in question, artwork may not be directly contributing to the acts of movement-building because of its selfish motives. Throughout my paper, all of the forms of Richmond city art discussed were pieces of public art that do not require money to view or promote. While the artwork may ultimately generate profit for the artists, they were not intended to perform that function and thus can continue to strengthen the BLM movement.

CONCLUSION

The use of art in protest not only strengthens the foundational pillars necessary for a successful movement, but also ultimately serves as a tactic that movements can deploy. As argued by Austin Hoffman in his article, “Black Lives Matter: Pain, Protest, and Representation,” the BLM movement was able to conjure “activism that gives communities in pain new and creative outlets for objectifying and validating the lived experiences of racism” (Timpf, 2017). Deployed as a tool by the BLM movement, art as protest has been helpful in actualizing and bringing representation to the struggles and hardships of the Black community. Shedding light on these issues was one of the key goals of the movement and art functioned as a tactic that could achieve that goal.

Thus, art as protest has overall been an effective tool that has led to the ongoing successes of the Black Lives Matter movement. Creative outlets have shaped many of the elements that constitute a social movement such as its mission and goals, mobilization strategies, collective identity formation, issue framing, institutionalization, and general tactics. Through dance, graffiti, music, technology, storytelling, and photography, these mediums have left a very positive effect on the movement-building elements of Black Lives Matter in Richmond, Virginia. However, the movement is not over yet, and more research will need to be done in future years in order to measure the true success of the movement and what extent of that success can be attributed to the artistic Richmond community.

REFERENCES


Engler, M., & Engler, P. (2016). This is an Uprising: How Nonviolent Revolt is shaping the Twenty-First Century.


Anaheed Mobaraki, a native of the great state of Maryland, is a senior political science major in Pauli Murray. Mobaraki’s research was inspired by her work this past summer at the ACLU of Virginia in Richmond, where she witnessed the rich culture and protest art associated with the Black Lives Matter movement first-hand. Her work led her to question how this protest art played a role in the formation and success of Richmond’s protests. Additionally, she was fascinated by the varying forms of art as well: there was digital art, more standard art, and graffiti—she took some photos herself of the artwork, including a photo of the infamous Robert E. Lee statue that circulated across various news agencies. Because she was able to experience the art in real time, and was able to take some of the photos herself, she got to make the research experience intensely personal. Undoubtedly, her writing focuses on artwork as explored through the written word, a fascinating process in which she was glad she could take part.

Beginning in her sophomore year, Mobaraki began volunteering with the Yale Undergraduate Prison Project (YUPP), tutoring students at a correctional facility 30 minutes outside of Yale. At the time, she did not know too much about the criminal justice system. However, after immersing herself directly in criminal justice work, she was able to break down all of the barriers, biases, and stereotypes she ever had about the system. This experience served as a launchpad for her; she became interested in police and prison abolition, abolition literature, and criminal justice reform. Despite her passion for teaching, the COVID-19 pandemic has significantly thwarted in-person tutoring opportunities, yet Anaheed has found a way to continue her criminal justice work by joining an organization entitled Mourning Our Losses. Born during the pandemic, this organization memorializes all the lives lost to coronavirus in American jails, prisons, and correctional facilities. She has been spending her time writing memorials and has been tracking and researching all of the names across four states and all I.C.E. detention centers, working to humanize a population that has been severely neglected yet brought to life during the pandemic in America.

As a first-generation college student, coming to Yale and being thrown into the intimidating academic environment was frightening. Yet, Mobaraki cannot stress enough the importance of reaching out to your personal librarian. After reaching out to her personal librarian her first semester four years ago, she learned how to find articles and manage citation resources through Zotero. Lastly, working through trial and error is sometimes the best way to approach research: start broad, but do not expect to end broad. Find the happy medium, narrowing down the scope, and work with your professor throughout the process. Staying confident, trying your best, and remaining dedicated—these three key components are essential to any research project.

For the full-length profile, visit yalesymposia.com
This illustration highlights the artistic activism that has enhanced the Black Lives Matter movement. I hope to show that—akin to the diverse protestors supporting Black Lives Matter—artists similarly generate support through communicating messages through their diverse practices. I convey the notion of “additive support” by depicting various overlappings of bright, eye-catching colors, and melding the true-to-life protest scene into the artist’s studio with similar background and foreground tones. The protestors and the artist overlook a cityscape, communicating the resurgence of Black Lives Matter “throughout the city of Richmond, Virginia.” Protests and art collaborate hand-in-hand, both advocating for concrete social change.

Based on the abstract from: “Art as Protest: How Creative Activism Shaped ‘Black Lives Matter’ in Richmond, Virginia”
The Morality of Pronoun Flexibility: Connections Between Language and Cognitive Identity Alignment

By Mafalda von Alvensleben

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ABSTRACT

The power of words we use to refer to one another is gaining recognition in contemporary socio-political discourse. Yet, interplay between language and complex cognitive processes, including moral judgments and identity formation, largely remains a subject of philosophical and theoretical debate. In order to begin examining the existence of such interactions empirically, this paper investigates the syntactic shift of the third person plural pronoun they/them to the third person singular, used to refer to gender non-binary/gender nonconforming individuals. Using grammaticality acceptance ratings and the Worthen 2016 moral attitudes test, administered under timed pressure, this study measures both intuitions surrounding the syntax of novel they/them pronoun usage and moral attitudes towards LGBTQIA+ individuals. Analysis revealed a strong positive correlation between high grammaticality ratings of novel pronoun (they/them) usage and moral attitude scores. These results may be the basis for future investigation into a psycholinguistic connection between intuitive judgements of syntax and complex cognitive processes i.e., moral judgments.

1.0 INTRODUCTION

Sometimes we drug ourselves with dreams of new ideas. The head will save us. The brain alone will set us free. But there are no new ideas waiting in the wings to save us as women, as human. There are only old and forgotten ones, new combinations, explorations and recognitions from within ourselves—along with the renewed courage to try them out.

- Audre Lorde from Sister Outsider: Essays and Speeches, 1984

The connections between human language and the mind are integral to our everyday experience, enabling us, as Chomsky’s theory of language goes, to transfer the contents of our own thoughts into the minds of others. Yet, as we move into a new decade, the importance of language as it refers to identity has taken center stage. For instance, in 2019, the American Dialect Society chose the pronoun “they” as their word of the decade in recognition of its growing usage to refer to gender non-binary individuals (The Guardian, 2020). In fact, the syntactic shift of the pronoun they/them from strictly third person plural to third person singular stands out as one of the most salient manifestations of the interplay between language and identity today.

The creation of new lexical items in a language occurs through a variety of mechanisms ranging from blending to borrowing to coinage of entirely new lexical items. Lexical item creation occurs through alterations to the different components of lexical items (phonology, syntax, morphology, and semantics) and happens regularly in “open” syntactic categories such as verbs, nouns, adjectives, and adverbs. Syntactic categories, in contrast to the more vaguely defined “parts of speech” that many are familiar with, refer to groups of lexical items that perform syntactic function as determined by linguistic tests (Linguistics Stack Exchange, 2013). Pronouns (part of the syntactic category pronominal) are considered to be closed class items, meaning that they are rarely altered, making the broadening of the they/them pronoun usage particularly monumental.1

This linguistic shift has grown in popularity following the rise of LGBTQIA+ activism and the introduction of theories from Women’s, Gender, and Sexuality Studies (WGSS), which posit that pronouns communicate our assumptions about people’s gender.2 Since gender identity has become a subject of moral and sociological debate,3 the pronouns used to refer to others can be thought of as a projection of one’s personal narratives about the gender identity of an individual (Brown, Frohard-Dourlent, Wood, Saewyc, Eisenburg 2019). These gender identity claims about gender identity and morality. This is more to acknowledge that in contemporary discourse in the United States, the validity of gender identities that fall outside of the gender binary is a matter of debate in many communities. This does not mean that your identity is or should be anything outside of what you know it to be. However, there remains significant community of people who (in my view, wrongly) reject the validity of this identity, which is, in part what inspired the writing of this paper.

1This was an aspect of both lexical item creation and syntactic categorization discussed in lectures by Professor Piñango.

2Here, gender refers to the notion that gender is a social construct created by factors such as behaviors and expressions of identity that include, but are not limited to, women/girls, men/boys, and gender diverse peoples. These exist on a fluid spectrum along which people’s gender identity can exist (Canadian Institute of Health and Research; Mikkola, M., 2017). By contrast, sex refers to sets of biological attributes in human and non-human animals and is generally associated with things such as reproductive hormones, chromosomes, and gene expression (Canadian Institute of Health and Research). This model of sex and gender, though widely accepted in many circles, has its drawbacks and flaws as pointed out by feminist philosopher Judith Butler (Mikkola, M., 2017). However, a more in-depth discussion of this falls outside of the scope of the study for the time being.

3Note from the author: In saying this, I do not make want to make prescriptive claims about gender identity and morality. This is more to acknowledge that in contemporary discourse in the United States, the validity of gender identities that fall outside of the gender binary is a matter of debate in many communities. This does not mean that your identity is or should be anything outside of what you know it to be. However, there remains significant community of people who (in my view, wrongly) reject the validity of this identity, which is, in part what inspired the writing of this paper.
1.1 Research Question

These concepts can be applied to Chomsky’s universal language theory, which postulates that language may be a mechanism for humans to transfer the contents of their minds into the minds of others, including their narratives. It then follows that if the linguistically communicated narrative of gender perception (through pronouns) comes into conflict with non-binary individuals’ internal narrative of gender identity, a conflict emerges between external and internal identity. For example, calling a non-binary individual “she” would be forcing them toward the “feminine” side of the spectrum, which is not aligned with their internal identity, a phenomenon known as “mis-gendering.”

According to self-verification theory (Kruglanski, Higgins, Swann, 2011), such conflicts can be incredibly distressing, rendering individuals more prone to mental health issues such as depression, anxiety, and substance abuse (Kruglanski et al., 2011), which nonbinary and transgender people suffer from at higher rates than average (Pachankis, 2018). Given the frequency with which pronouns are used in our everyday language, one can imagine the experience of being constantly “mis-gendered” as a “death by a thousand cuts” of sorts for one’s cognitive well-being.

However, the notions explained above are primarily products of theory, philosophy, and self-reports/general culture which have not been empirically tested. Therefore, this paper seeks to investigate a preliminary connection between language and moral judgments by asking if grammatical acceptability ratings of the third person singular pronoun they/them is positively correlated with positivity scores in Worthen’s 2016 moral attitudes test towards LGBT+ individuals. This is of interest for the field of linguistics as it investigates the semantic/pragmatic implications of the rare case of novel pronoun application. Further, pronoun usage exists at an intersection between intuitions about syntax and psychological and contemporary cultural questions about identity. So, establishing a connection between grammatical and moral judgments may suggest the existence of psycholinguistic mechanisms through which moral judgements influence language usage at level of syntax.

1.1 Research Question

Are judgments about the grammatical acceptability of pronouns a manifestation of a person’s moral attitudes? Here, moral attitudes refer to overall moral attitudes toward the LGBTQIA+ community including questions that probe participants’ feelings surrounding gender attribution (i.e., gender presentation, preferred pronoun usage, and acceptability of a gender spectrum in contrast to a gender binary).

2.0 METHODS

2.1 Subjects

Participants for this study consisted of family, friends, and peers of age 18 and over consenting to participate in a 10-minute anonymous survey. Participants included in the final analysis were all self-identified fluent English speakers with all non-fluent respondents excluded from final analysis. No age, ethnicity, or gender restrictions were grounds for exclusion as the aim is for results to remain as generalizable as possible to “English speakers.” This study received IRB exemption from Yale University.

2.2 Linguistic Materials

Participants rated the grammaticality of 20 sentences modeled after Bradley et al. (2019) under time pressure. It was assumed that when participants rated grammaticality, they took the ordinary perspective on language: a prescriptive perception of language “correctness” according to sociological factors (Piñango, 2020). Sentences consisted of minimal pairs where one sentence randomly contained either gender neutral pronouns, they/them or a typical/gendered pronoun (he/him or she/hers) evenly distributed across trials. E.g., “Sam liked their ice cream very much,” versus, “Sam liked her ice cream very much.”

Four types of sentence subjects were used: gendered names, gender neutral names, nameless definite, and nameless generic. Gendered names had a robust normatively gender connotation measured by census data of birth certificates, from which it was assumed that the likelihood participants were exposed to, for example, females (normatively she/her/hers pronoun users) with the name “Sarah” were higher. Gender neutral names were those that had a variable sex connotation, also measured by census data of birth certificates, from

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4 This may also be thought of as “mind melding” in terms of cognitive psychology.

5 Methodology drawn from a presentation given in lecture by Professor Piñango.

6 The test from Worthen’s 2016 paper is entitled utilizing only the first few letters (LGBT) representing lesbian, gay, bisexual, and trans* individuals. However, it is important to note this community encompasses more identities than the four identities highlighted in the acronym including asexual, intersex, queer and so much more as denoted in the more widely used LGBTQIA+ where the “+” denotes aspects of the gender and sexuality spectrum that do not or have not yet found words to describe or encompass them.

7 Presently, definitive data on the number of people in the United States who identify as gender non-binary was not found in this literature review. Unfortunately, it is not yet standard practice for comprehensive demographic surveys to include options for preferred pronouns and gender identities outside of the gender binary. For the purposes of this paper, we assume present norms predict that the majority of the population utilizes pronouns that exist exclusively in the gender binary. Nevertheless, according to a survey conducted by The Trevor Project (2020), 1 in 4 LGBTQ+ youth use pronouns that fall outside of the gender binary, illuminating a growing trend toward acceptance and normalization of gender as existing on a spectrum in younger generations.

8 [Survey v1: https://yalepsych.qualtrics.com/jfe/form/SV_aW2emuTLiT-G9IZ23] [Survey v2: https://yalepsych.qualtrics.com/jfe/form/SV_5jWfh1T7D8usuSF]
which one could assume a higher likelihood that participants were exposed to both males and females (normatively determined users of he/him/his and she/her/hers pronouns, respectively) with the given name. For example, the name “Taylor” is used for both male and female babies who are likely to go on to use he/him and she/her pronouns, respectively. All names were chosen using a database provided by the Department of Social Security (see References).

To widen the scope of pronoun-use contexts, a nameless definite condition was included, meaning that the subject was “nameless,” and the sentence linguistically constructed to remain in the singular (Bradley et al., 2019). E.g., “My friend went to the store.” To ensure stimulus robustness, the nameless generic condition served to replicate previously demonstrated acceptability of the third person singular use of they/them pronouns to refer to semantically categorized “generic” subjects in English (Bradley et al., 2019), e.g. “A person must learn to tie their shoes.” The logic follows that generic subjects were not linked with sociological perceptions of gendered information and should, therefore, have no correlation to broader issues of gender identity. Finally, to create a lower base rate for grammaticality ratings, intentionally ungrammatical controls for each sentence type (from which the ungrammaticality stems from pronoun usage) were included. E.g., “The person arrived at she home.”

2.3 Design

There were two versions of the survey (one version per participant), each containing equal sets of sentence types (elaborated in section 2.2) with one version containing a gendered (she/her or he/him) or neutral pronoun (they/them) and the other containing the reverse, forming controlled minimal pairs (see Appendix). Each survey also included a series of ungrammatical sentences as controls. Each version had equal numbers of each pronoun and sentence type in a randomized order.

The survey took an estimated 10 minutes on average to complete. The first set of questions asked for the participant's age and English proficiency. Following this, participants were presented with sentences and asked to rate them on a five-point scale, 1 being “completely ungrammatical” and 5 being “completely grammatical.” Next, participants took the moral attitudes towards LGBT individuals test (Worthen 2016), where questions were rated on a seven-point scale from “strongly agree” to “strongly disagree.” A countdown timer was included at the beginning of each section to discourage participants from overthinking the survey. This is because the study aims to explore implicit connections between pronoun usage and morality in order to understand how participants make judgments about pronouns on a day-to-day basis. Here, participants were assumed to make these day-to-day moral judgments rapidly, remaining largely incognizant of the moral implications of pronoun usage.

<table>
<thead>
<tr>
<th>Sentence Type</th>
<th>Gender Neutral Pronoun (They/them)</th>
<th>Gendered Pronoun (she/her or he/him)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gendered Name</td>
<td>p=0.0284</td>
<td>p=0.5556</td>
</tr>
<tr>
<td>Gender Neutral Name</td>
<td>p=0.007503</td>
<td>p=0.3077</td>
</tr>
<tr>
<td>Nameless Definite</td>
<td>p=0.002656</td>
<td>p=0.4724</td>
</tr>
<tr>
<td>Nameless Generic</td>
<td>p=0.9384</td>
<td>p=0.9225</td>
</tr>
<tr>
<td>Overall gender-neutral pronoun and morality</td>
<td>p=.01446</td>
<td>N/A</td>
</tr>
<tr>
<td>Controls</td>
<td>p=0.3456</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 1: Compiled p values for each sentence type (gendered name, nameless generic, etc) and pronoun type (she/her, they/them)

The data was encoded based on the sentence type, as well as as pronoun usage (see Appendix) and scored based on the survey responses, yielding an overall grammar rating for each combination respectively. Similarly, the Worthen 2016 was scored based on survey responses to yield an overall positivity score for each participant. The scores were subsequently correlated using R software, yielding a p-value for each individual sentence type.

2.4 Procedure

Surveys were distributed via text message, email, and Facebook and randomized for survey version, utilizing recruitment materials (see Appendix). Data collection lasted for one week to allow for a sizable number of respondents.

2.5 Predictions

The use of the third person singular pronoun they/them/their is to be rated as more grammatically correct by individuals who have positive moral attitudes towards gay/queer, bi/pansexual, trans, and non-binary people.
3.0 RESULTS

All data was collected through coded Qualtrics survey software. The survey was closed with a final N=109 (35 men, 56 women, and 2 nonbinary) with respondents between the ages of 15-75. Data was analyzed using R software to calculate p-values for each individual combination of sentence type along with the corresponding pronoun type.

Positive correlation between morality score and grammaticality score of first person singular they/them (composed of gendered, gender neutral, and nameless definite sentence types) was statistically significant (p = .014). Significance from the composites of this average are as follows: nameless definite condition with a positive correlation between nameless definite sentences and morality scores (p = .003), followed by a positive correlation between the gender-neutral name condition and morality scores (p = .008), and a positive correlation between gendered name condition and morality scores (p = .028). Further, no statistically significant correlation was found between the morality scores and sentences using gendered pronouns (p=0.5556, p=0.5077, p= 0.4724, p=0.9225 for gendered name, gender neutral name, nameless definite, and nameless generic conditions respectively).

Given the frameworks discussed in previous sections regarding WGSS theory, one might have predicted high grammaticality scores to correlate with low moral attitude scores. However, this paradigm focuses primarily on violations of syntactic shifts in gender neutral pronoun use. Further, given that the sample of individuals surveyed had little to no distribution of extremely low scores on the morality survey component, it becomes even more difficult to make any conclusive claims on matters outside of gender-neutral pronoun usage. Despite this, the breakdown preliminarily confirms the prediction of a statistically significant positive correlation (p < .05) between moral judgments of LGBTQIA+ individuals and grammaticality ratings of third person singular they/them pronouns exists.

The nameless generic condition (sentence with generic, unnamed subject e.g., “a person,” “an athlete,”) had a p-value of .923 for the “gendered pronoun” condition and p = .939 for the “gender-neutral pronoun” condition. As expected, these results are not statistically significant in concurrence with previous research findings (Bradley et al., 2019). Lastly, the “ungrammatical” condition found no correlation indicating at least partial understanding of the surveyed stimuli for research purposes.
DISCUSSION

The aim of this study was to gain a better understanding of the connection between influences of higher-level mental processes and language as well as investigate possible semantic/pragmatic implications of a markedly rare change in lexical items in the pronominal syntactic category. The introduction of the third person singular pronoun they/them is taken as an ideal subject to study this, as it exemplifies how everyday language syntax can be used to communicate newly personal and salient aspects of semantic/pragmatic judgments of identity (in this case, gender identity). Though the design of this study does not get at the direction of this interaction (mind to language or language to mind), the positive correlations between sentence and morality judgements give tentative reason to believe that some important connection exists between judgments of language and judgments of morality in the case of pronoun usage and support for the LGBTQIA+ community.

Again, these results are strictly correlational, meaning that nothing can be said of causational mechanisms or directionality of the observed effect. However, this study can be used as a means to highlight a viable line of empirical inquiry that seeks to understand connections between moral judgments and their manifestation in the subtleties of language or vice versa. Further, if a robust link between these factors exists, there may also be a psycholinguistic justification for the importance of conscientious or “politically correct” language, as it may be a direct manifestation of our moral acceptance of an individual’s gender identity. Given the importance of alignment between external and internal moral narratives/identity for mental health, this research could be used specifically to help understand a mechanism by which LGBTQIA+ individuals experience higher rates of mental health problems.

APPENDIX

Sentence Stimuli

Gender neutral names

River made the chicken that __ mom recommended. Her/Their

Gendered names

Mike took a hot shower after __ got back from work. She/They
Sarah sleeps in when __ dog stays quiet. Her/Their

Nameless generic

When a friend helps me, I try to help __ too. Them/Her

Ungrammatical Controls

After Taylor finished work, __ decided to go to the movies. They/She
The teacher called on Sam to see what __ answer was. Their/her
Ro ordered the food when it was his turn. His/Their

Gendered names

Mike took a hot shower after __ got back from work. She/They
Sarah sleeps in when __ dog stays quiet. Her/Their

Nameless generic

When a friend helps me, I try to help __ too. Them/Her
If someone makes a mistake __ must keep going. She/They
When a child asks for my help, I try to give it to __. Him/The
A runner should always stretch __ body before working out. Her/Their

Ungrammatical Controls

Nameless definite
When my friend arrived at work, __ sat at His/their desk. Him/Their

Nameless generic
If a driver is tired __ should take a break. Her/Them

Gendered name
Lily walked out of __ apartment when it was time for work. Them/Him

Gender neutral name
Rowan arrived at __ class on time. They/Him

Worthen’s Moral Attitudes Towards LGBT Individuals

CW: This questionnaire features statements and language that describes sexual anatomy. There are also questions which probe conceptualizations and attitudes towards LGBTQIA+ individuals that are overtly homophobic/transphobic. This may be distressing for readers. Unfortunately, these statements encompass widely held beliefs/attitudes about LGBTQIA+ individuals today in the United States; many of which are still discriminatory and dehumanizing. I feel the need to say explicitly: no matter your identity or who you love, you are worthy of care, respect, and humanity.

I would not mind going to a party that included gay/lesbian/bisexual/queer people.

I would not mind working with gay/lesbian/bisexual/queer people.

I welcome new friends who are gay/lesbian/bisexual/queer.

I do not think it would negatively affect our relationship if I learned that one of my close relatives was gay/lesbian/bisexual/queer.

I am comfortable with the thought of two men or two women being romantically involved.

I would remove my child from class if I found out the teacher was gay/lesbian/bisexual/queer.

It is alright with me if I see two men or two women holding hands.

I would not vote for a political candidate who was openly gay/lesbian/bisexual/queer.

Marriages between gay/lesbian/bisexual/queer people should be legal.

I am morally against gay/lesbian/bisexual/queer people being parents.

Being gay/lesbian/bisexual/queer is morally wrong.

Being gay/lesbian/bisexual/queer is a sin.

Being gay/lesbian/bisexual/queer is a mental disease.

Physicians and psychologist should strive to find a cure for non-straight (gay/lesbian/bisexual/queer) people.

Gay/lesbian/bisexual/queer people should undergo therapy to change their sexual orientation.

Most men and women who call themselves bisexual/pansexuality are temporarily experimenting with their sexuality.

Just like homosexuality and heterosexuality, bisexuality/pansexuality is a stable sexual orientation for people.

Being bi/pansexual is morally wrong.

Sex change operations are morally wrong.

If I found out that my best friend was changing their sex, I would freak out.

If a friend wanted to have their penis removed in order to become a woman, I would openly support them.

Men who see themselves as women are morally wrong.

Women who see themselves as men are morally wrong.

I would avoid talking to a woman if I knew she had a surgically created penis and testicles.

It is morally wrong for a woman to present herself as a man in public.

It is morally wrong for a man to present himself as a woman in public.

Gender is a spectrum where your gender identity is what you feel you are and sex is what you are biologically assigned and these two things are separate.

Table 2: Data coding

<table>
<thead>
<tr>
<th>Code</th>
<th>Definition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>ng</td>
<td>nameless gener</td>
<td>8</td>
</tr>
<tr>
<td>nd</td>
<td>nameless defini</td>
<td>8</td>
</tr>
<tr>
<td>gn</td>
<td>gendered name</td>
<td>8</td>
</tr>
<tr>
<td>uc</td>
<td>ungrammatical</td>
<td>8</td>
</tr>
<tr>
<td>nn</td>
<td>gender neutral</td>
<td>8</td>
</tr>
</tbody>
</table>

Pronoun

| n    | gender neutral             | 16    |
| a    | gendered pronoun           | 12    |

Combined

| ng.a | nameless gener             | 4     |
| ng.n | nameless gener             | 4     |
| nd.a | nameless defini            | 4     |
| nd.n | nameless defini            | 4     |
| nn.a | gender neutral             | 4     |
| nn.n | gender neutral             | 4     |
| uc.uc| ungrammatical              | 8     |
| gn.n | gendered name              | 4     |
| gn.a | gendered name, gendered pronoun |     |
Being nonbinary/genderfluid is morally wrong (here non binary/genderfluid means not identifying as a man or woman).

ACKNOWLEDGMENTS

Thank you to both Professor Piñango and Chris Geissler for their passion and dedication to getting everyone excited about linguistics. I will never think of language the same way again, and I am eternally grateful.

Also, thank you to Ken Steir for your patience with my number and R incompetence and listening to me ramble about “self-verification theory, lexical conceptual structures, hermeneutical resources, and how this all ties into some pronoun business,” into the wee hours with frayed hair, in massive fluffy robe, and one eye that wouldn’t stop twitching. I marvel at your courage.

Lastly, I thank Joanna Blake Turner for sharing her work on philosophy surrounding gender identity which sent me off on this train of thought in the first place.

RESOURCES

Trevor Project: The Trevor Project is the leading national organization providing crisis intervention and suicide prevention services to lesbian, gay, bisexual, transgender, queer & questioning (LGBTQ) young people under 25. To call or text: (866)-488-7386

GBT National Youth Hotline (ages 23 and under): Free and Confidential peer support for the LGBTQ and questioning community ages 25 and younger. Mondays to Fridays from 1 pm – 9 pm PST and Saturday from 9 am – 2 pm PST. Call: (800) -246-7743

WEAVE Crisis Intervention For Domestic Violence and Sex Trafficking/Sexual Assault: All of WEAVE’s services can be accessed by calling the Support and Information Line. WEAVE’s 24-Hour Support and Information Line offers immediate intervention and support by trained peer counselors. Help is available in over 23 languages. Call: (916)-920-2952

REFERENCES


https://cihr-irsc.gc.ca/e/48642.html


Mafalda von Alvensleben is a sophomore in Benjamin Franklin College, studying cognitive science with a concentration in contemporary ethics and the future of morality. With a keen interest for language and cognition, von Alvensleben’s research article was initially a paper from her class “Language in the Mind” with Professor Maria Piñango. Her interest in the topic of pronouns kick started from her interactions with her parents and their friends.

“When my parents moved to the States from Germany, they created a kind of community of expats. This means we have a lot of friends that are from all over the world, so we had a lot of accents and languages going on around the dinner table.” von Alvensleben recalls. Though not always understanding the specifics of what was said, this introduced her to the fluidity of language and its use as a part of what brings people together. She continues, “being a part of the Queer and Disability community and having the chance to learn from others in those communities, though, I began to think more deeply about the words we use to refer to one another and the weight that they carry, especially surrounding things like identity.”

To dive further into this topic, von Alvensleben decided to choose a research topic on whether the moral attitudes toward LGBTQ+ individuals predict how comfortable people are with using pronouns. She also participates in neuroscience research with the Crockett lab, researching moral storytelling—stories others tell in order to communicate something about themselves more specifically, for example, “cancel” culture. Outside of the Crockett lab, von Alvensleben manages production for the Yale Undergraduate Research Journal, designs costumes for theater, and serves as the president of Disability Empowerment for Yale. She is also enrolled in the five-year Masters of Public Health, where she will concentrate in social and behavioral science. Ultimately, von Alvensleben is interested in diving deeper into bioethics, disability rights, and public policy.

For the full-length profile, visit yalesymposia.com
Do religious donors give strategically or idealistically? The entanglement between the conservative Republican party and religious groups, particularly evangelical Christianity, on issues of abortion, sexual mores, and family values makes it difficult to analyze this question along voting lines. Regardless of how one votes, citizens and organizations can still punish their political leaders for moral infractions by voting with their wallets. This study aims to discern if there is a relationship between political scandals and religious donations.

INTRODUCTION

The intersection between evangelicalism and conservatism in America inconveniently termed as “the Christian Right” has had to undergo some soul searching amid the controversial years of the Trump presidency (Putnam, Campbell, & Garrett, 2010). According to Doug Pagitt, the executive director of the Christian campaign organization, “Vote Common Good,” evangelical voters are increasingly on the fence about supporting a president who appears to lack “kindness and decency” (Sherwood, 2020). However, if religious individuals have legitimate strategic reasons to support the Republican party, such as the seriousness of abortion, then policy positions might outweigh qualms over the moral character of individual politicians. In fact, this positioning may even make moral infractions committed by office holders seem irrelevant.

This paper addresses the significance of moral infractions for religious support and, in particular, for religious donations. Religious donations are chosen as an outcome variable because, unlike votes, donations are continuous instead of discrete and are a more demanding political activity with direct financial costs. Therefore, religious donations may be more sensitive to moral infractions, or put another way, religious donations may be more elastic to moral infractions, revealing how religious individuals react to moral qualms in a way that voting cannot.

I begin by examining the existing literature on religious motivations for political donations. Then, I describe the specific question this paper attempts to answer and establish several scope conditions, as well as the proposed methodology for answering those questions. Following which, I demonstrate through statistical evidence from several Congressional races that, surprisingly, moral infractions do not significantly depress political donations from religious individuals. In fact, in most cases, strategic considerations seem to dominate religious donors. I show these effects by breaking down the observed data into cases. Subsequently, I analyze how this trend has interacted with other trends such as the #MeToo movement and increasing partisanship.

The implications of such a study have immediate political significance. In a two-party system in the US, it can be difficult to measure support. People can vote strategically for the lesser of two evils even when their personal views are misaligned. Donations act as a signal of whether politicians are gaining or losing ground in their respective races. If religious donors really are sensitive to moral infractions, then politicians must also pay attention to their personal conduct when running for office. This may be especially salient as the sums of money raised for various elections have grown exponentially over the past several election cycles.

LITERATURE REVIEW

Religiosity has been shown to be a strong predictor of political attitudes (Cohen-Zada, Margalit, & Rigbi, 2016), and there is some evidence of causality (Hungerman et al, 2018). Studies have also shown that political campaign stops can affect religious donations (Hungerman et al, 2018). Jones-Correa and Leal (2001) suggest that religious participation trains civic skills that drive political participation.

Studies have also shown that moral infractions by religious leaders have led to a direct decrease in religious donations to religious organizations (Hungerman, 2013). It is not too far off to speculate that moral infractions by political leaders might lead to decreases in political donations amongst religious individuals (Bottan, 2015). Hungerman (2013), in a similar study, lends support to the religious marketplace hypothesis by demonstrating that declines in Catholic donations can lead to upticks in donations to other non-Catholic organizations. The religious market
model suggests that churches as institutions can strategically engage in politics when it suits their interest in retaining members. However, does the same kind of strategic thinking apply to members themselves? Such models imply that strategic interests trump ideological principles when religion interacts with political processes.

In the literature, political contributions can be analyzed as monetary surrogacy, where individual donors are able to use their financial resources to expand their political influence beyond the numerical and geographical limitations of their vote (Gimpel, Lee, & Pearson-Merkowitz, 2008). Gimpel, Lee and Pearson-Merkowitz (2008) show that a majority of campaign contributions come from nonresidents and that these contributions are mostly driven by strategic partisan interests. They also demonstrate the effect of access-seeking and expressive/identity purposes, but these effects remain small in comparison to strategic interests. This result is strengthened by Ovtchinnikov and Pantaleoni (2012), who show that campaign contributions can also be driven by strong economic interests by demonstrating an effect of economically dependent geographies on relevant political contributions. While expressive/identity interests come closest to an analysis on religious donors, these studies largely omit religiosity as a factor. This paper seeks to analyze whether flows of money are predominantly strategic, or if religious and moral considerations can serve as an effective moderating factor.

Despite the fact that religious voting is associated with the Republican party, statistics from open secrets.org reveal that the majority (62%) of donations in 2014 have gone to support Democrats. However, the total amount donated by individuals with religious associations are rather small, totaling only 1.6 million US dollars. Given that the largest institutional donor is the United Methodist Church at roughly $400,000, and they overwhelmingly donate to the Democratic party, it seems like, contrary to popular belief, the religious left is more politicized than the religious right (CRP, 2020).

**METHODOLOGY**

In order to determine if religious donors are sensitive to moral infractions, which can be characterized as an exogenous shock, this paper examines if donations changed after a publicly observable moral infraction, as compared to donations before the infraction in the same race. I use a regression discontinuity approach, where religious ZIP codes above a certain threshold are exposed to a moral infraction in the same race. The second set of controls were the (relatively) non-religious donors in the same race. These non-religious donors were exposed to the same moral infraction as their religious counterparts. This approach tested if religious donors were comparably more sensitive to moral infractions than their non-religious counterparts after being exposed to the same treatment.

All the code and data for this project, with the exception of the open secrets.org data, which can be found on open secrets.org, are available on this public git repository: https://github.com/bradleyyam/notty-heads.

**DATA**

In order to build a dataset of donations before and after a moral infraction, publicly available misconduct data from the House Ethics Committee was obtained through govtrack.us (Govtrack, 2020). Publicly available campaign contribution data was obtained from open secrets.org (CRP, 2020). Publicly available data on religious adherence was obtained from the “2010 U.S. Religion Census: Religious Congregations and Membership Study, 2010 (County File)” (ASARB, 2010), along with other datasets that helped us match candidate ids between datasets and map ZIP codes to county FIPS codes (Govtrack, 2017; niccolley, 2017).

The resulting data had the following dimensions:

1. Campaign Contribution Data: 26,059,493 observations. These contributions were dated from 1 Jan 2017 to 31 Dec 2018 and focused on the 2018 Congressional Races. The data included: Receiver ID, Date, Contributor Industry, Contributor ZIP Code, Contributor Gender, Contributor Occupation, Amount. All observations are individual contributions.

2. Misconduct Data: 23 observations. These observations were dated from 1 Jan 2017 to 31 Dec 2018. They included the first date of the allegation and the details of the allegation, as well as the name and ID of the candidate.
3. Religiosity Data: 3149 observations. Each observation represents a unique county. The data includes information on the population of each county, and the rates of adherence of a particular denomination in each county.
4. Legislator Data: Maps unique ids for each legislator between openscrets.org data and govtrack.us data.
5. ZIP Code Data: Maps each ZIP code to their respective County FIP code.

DATA WRANGLING

Campaign contribution and misconduct data were combined to generate 10 discrete time-series datasets that each represented one congressional race. Of the 23 misconduct instances that were selected, only 10 fulfilled the following criteria:

1. At least 30 observations in each race of campaign donations before the alleged misconduct and after.
2. Misconduct happened before the elections and after the last cycle of elections.

An interesting outcome of this initial exclusion is that most sexual misconduct cases were dropped from the analysis. This includes the cases concerning candidates Elizabeth Etsy, Patrick Meehan, Trent Franks, Al Franken, John Conyers, Jr, Filner, and Weiner. There is insufficient data after the first date of the allegation because a majority of these cases ended in their resignation.

Subsequently, another culling was performed based on the availability of data once filters were applied to narrow the analysis to the religious donors in each race. In addition, each race also needed a matched control with sufficient data.

Only a few congressional races that fulfill the criteria above remain: Devin Nunes, Raul Grijalva, Robert Menendez and Rod Blum.

IDENTIFICATION

Since religiosity of each donor cannot be directly measured, two proxies were used to create a binary variable. First, the Realcode of the donation was interpreted such that any donations coming from religious Realcodes were classified as religious. Second, counties with religious adherence rate in the upper quartile of the overall religious distribution were classified as religious, and donations coming from ZIP codes that were mapped to those counties were also classified as religious. I focused explicitly on the largest three denominations of Christianity in the US: Mainline Protestants, Evangelical Protestants, and Catholics. This focus captures a broad definition of religiosity, while noting the significant role that Christianity, in particular, plays in US politics (Putnam et al., 2010).

Although this is not a foolproof estimator of religiosity, given that this analysis is only looking for an effect across time, and intuitively religious communities might tend to be more homogenous, I argue that this is a reasonable estimation to make. Since America has a long tradition of religiosity stretching back to the founding fathers and has long been considered a “Christian nation,” this identification estimation is less about trying to distinguish religious from irreligious people, but more about distinguishing the relatively more religious from the relatively less religious. As such, this study effectively uses “religious” as a shorthand for referring to “people who live in relatively religious regions.” The same measure of religiosity was used to filter the observations in the control group as in the treatment group.

CONTROL GROUPS

In order to discover a control group, the time-series sum of donations per month for each misbehaving candidate were matched across the entire population of 2767 other congressional candidates receiving campaign contributions for the 2018 election using a statistical correlation test. This high number of available matches means that more complicated methods like propensity score matching were relatively intractable. Moreover, by isolating the pre-treatment time series as a primary variable for matching, I ensured that the most important variable, contributions, were matched. At least 2 controls were matched and combined to make a synthetic control, thus reducing the possibility of statistical artifacts by averaging across multiple races.

The following criteria were used to select candidates for synthetic controls:

1. Pearson’s correlation score of 0.8 or higher for pre-treatment contribution trends, sum of contributions aggregated in each month.
2. Same party
3. Same geographical region (Midwest, Northeast, etc.)

Rather than using a weighted average similar to Abadie’s synthetic controls (Abadie et al., 2015), contributions were simply aggregated together. This simplification in method preserved the actual value of each individual contribution, which matters when analyzing the effect of the treatment. Moreover, since the absolute amount of campaign contributions generally differs according to a variety of factors, this analysis was not concerned about matching on the absolute amount, but matching the pattern of change in the amount using the diff-in-diff approach. Hence, a weighted average is not necessarily a better approach.

Regressions were also conducted on non-religious donors vis-à-vis religious donors regarding individuals with alleged misconduct within the same congressional race. Since the religious and non-religious groups both underwent the treatment, this method allowed me to investigate whether religious donors were more sensitive to the moral infraction than their less religious counterparts.
<table>
<thead>
<tr>
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<tr>
<td>(Intercept)</td>
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<td>(5678.01)</td>
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<td>−12627.67***</td>
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<tr>
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<td>−10060.17**</td>
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<td>(110.00)</td>
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<td>religious</td>
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<td>−10060.17**</td>
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FINDINGS

The results surprisingly demonstrate that if there is any statistically significant relationship between moral infractions and campaign contributions, it is likely to be positive. That is, religious contributions tend to go up for candidates who commit moral infractions, but not in every case. For two candidates, Raul Grijalva (Table 1, \( p=0.183, R^2=0.0090 \); Table 4, \( p=0.0558, R^2=0.2513 \)) and Devin Nunes (Table 1, \( p=0.0398, R^2=0.0970 \); Table 4, \( p=0.7140, R^2=0.0741 \)), the effect was not statistically significant. However, for Rod Blum (Table 1, \( p=0.0032, R^2=0.0999 \); Table 4, \( p=2.19e-12, R^2=0.2048 \)) and Robert Menendez (Table 1, \( p=2.02e-06, R^2=0.0686 \); Table 4, \( p=3.47e-06, R^2=0.0863 \)), it was significant and positive.

Even if it is unclear how the dollar amount of individual contributions fluctuates, there seems to be a compensatory effect in most cases, where the frequency of contributions increases in the same period, so that the net effect on the total sum received by contributors tends to be higher overall (Table 3: \( p=[0.0092, \ 0.0403, \ 0.0344, \ 0.1770] R^2=[0.73, \ 0.4931, \ 0.4591, \ 0.4528] \) and Table 6: \( p=[0.9489, \ 0.4796, \ 0.0325, \ 0.0032] R^2=[0.1237, \ 0.09101, \ 0.531, \ 0.415] \)). Although it is the case that the frequency of contributions tends to increase for competitive congressional races closer to the election date in November 2018, the increase in the frequency of contributions was still statistically significant from the baseline controls (Table 5: \( p=[0.5591, \ 0.0023, \ 0.0138, \ 0.0052] R^2=[0.0303, \ 0.4551, \ 0.4963, \ 0.476] \)).

While Rod Blum experienced a strong reduction in the dollar amount of his contributions, he also saw more contributions after his alleged misconduct, leading to a statistically insignificant change in his total contributions. Raul Grijalva appeared to have no significant change in any of the metrics. Devin Nunes and Robert Menendez both saw a statistically significant increase in the frequency of contributions after the alleged misconduct. Robert Menendez also saw an increase in the dollar amount of individual contributions which netted a statistically significant increase in the sum of contributions per month after the alleged misconduct.

These findings are made more puzzling by the fact that when religious donors are compared to non-religious donors in the same congressional race with alleged misconduct, religious donors seem to contribute less than their non-religious counterparts after the misconduct (Figure 1). I will argue later that this is a statistical artifact, but it is an important one that informs us about the contribution patterns of religious donors.

ANALYSIS

These results are surprising. Rather than showing a decrease in support for congressmen with alleged misconduct, they show an unclear dollar amount of individual contributions and at least some positive effect on the frequency of contributions post-misconduct.

It is important to look at all three outcome variables, namely,
individual contributions, the frequency of contributions, and the sum of contributions, over each week to get an accurate picture of what is happening. For instance, an increase in sum of contributions and individual contributions but a decrease in frequency of contributions amongst religious donors can be interpreted as donors who are both religious and strategic doubling down on their partisan interests while other religious donors withdraw their contributions entirely.

Before diving into the analysis of the respective races, it is worth addressing the broader pattern of how religious donors tend to donate. In examining the graphs below that compare non-religious donors (classified as 0) and religious donors (classified as 1), given that most of the misconduct instances happen just before this surge, one might be misled into thinking that contributions from religious donors were depressed by the misconduct. However, my analysis with the appropriate controls informs us that this is not the case. Rather, religious donors are simply more consistent and are not as sensitive to the time fixed effects that produce a surge of donations right before the election.

This pattern is clearly reflected in Figure 1, where one can see that non-religious contributions are more sensitive to the timing of the election in November than are religious contributions. However, Figure 2 demonstrates that in comparison to the synthetic controls, religious donors tend to donate more after a moral infraction.

Additionally, note that I am not able to study most instances of sexual misconduct, at least in the 2018 races. This is because all congressmen accused of sexual misconduct resigned from their races. Sexual misconduct in the #MeToo era appears to be anathema for any sort of political office.

The following sections will analyze each congressional candidate and elaborate on the circumstances surrounding their misconduct and their campaign success.

**RAUL GRIJALVA**

The case study of Rep. Raul Grijalva of Arizona District 03 allows us to investigate if religious donors are sensitive to debauchery and drunkenness in their political leadership; behavior that is traditionally frowned upon almost as much as sexual misconduct. The House Ethics Committee described Grijalva’s offense as creating “a hostile work environment and being frequently drunk” (Marcos, 2019). Despite this misconduct, there does not seem to be a reduction of support in the dollar amount or the frequency of his individual contributions.

This consistent monetary support is in spite of the fact that Rep. Grijalva runs in a relatively uncompetitive election. As the incumbent, he has been consistently re-elected since 2002 with healthy margins of up to 63% of the vote. In 2016, he ran unopposed. In 2018, he raised $697.82K while his opponent only raised $77K. This lack of competition should have been an opportunity for religious voters to punish his behavior by withholding their monetary contributions while still reaping the ben-
Rep. Devin Nunes has been embroiled in many controversies of the Trump Administration, the latest of which being the attempt to discredit Joe Biden with other allegations over corruption, but in 2017 and 2018, he had been involved in the investigations into Russia’s influence in the 2016 presidential election. Nunes was also a key player in Trump’s transition team.

Nunes’ election in 2018 was a relatively competitive one, and it was also very expensive. Nunes raised $12.62 million, while his opponent raised $9.09 million. Like Grijalva, Nunes had occupied his seat since 2003 and had run several times unopposed. Nunes’ popularity and his donations increased exponentially after Donald Trump’s election, and it is evident that his participation in the Trump Administration earned him many financial supporters. Nunes’ involvement in the Trump Administration is a confounding factor for any analysis of his campaign contributions post 2016. There was a statistically significant increase in the frequency of campaign contributions to Nunes post-allegation (Table 1, $p=.0138$, $R^2=.4963$). Given that his support base is roughly 52% small contributors, it is likely that his involvement in the Trump Administration might have given him the platform to turn the allegation into a rallying point for an increase in contributions. Otherwise, it could be that the competition surrounding his seat also drove more contributions post-allegation. Moreover, this allegation was also not the first House Ethics Committee investigation into Nunes. Previously, the Committee had investigated Nunes for releasing confidential information in the Russia investigation. Like Rep. Menendez, previous investigations could have inured the public to the signal of moral infractions.

**DISCUSSION**

How do we interpret these results? It is tempting to conclude that when it comes to politics, religious individuals are just as strategic as non-religious ones: voting and donating according to what best advances their own interests, regardless of any moral ideals. Certainly, this interpretation would follow along the theme in the religious rational choice literature, which indicates that religious people can be expected to act rationally (according to their self-interest) but with a different set of fundamental assumptions about the world (Scheve & Stasavage, n.d.).

However, I suggest that the jury is still out. The misconduct data
issued by the House Ethics Committee presents a good but incomplete view of misbehavior among Congress. Moreover, the four races that I analyzed are a very small sample of the universe of possible moral infractions to investigate. It could be that religious donors are reacting to signals beyond what the House Ethics Committee publishes. For example, Robert Menendez’s support could have come from a sense of injustice at his exoneration in 2017 but subsequent retrial in 2018. It might also be that religious donors simply weigh the moral effects of their political contributions more than the moral character of their political leaders, leading them to donate strategically (Putnam et al., 2010). Additionally, Raul Grijalva’s case could also imply that religious donors are simply inattentive. More broad-based analyses that consider different measures of moral infractions and more detailed analyses that look into the exact sentiment of the religious base are necessary before any final conclusions can be drawn.

The conclusions that can be drawn from the data are that religious donors are in general more consistent donors as compared to their non-religious counterparts. This consistency could be due to the practice of alms-giving or regular religious donations that shape their practice of political contributions. Together with the observation that news about moral infractions might not cause religious donors to entirely drop the support of their candidate, this has implications in particular on campaign ad-spending. Further research could examine if campaign ad-spending for political contributions has a better return on investment in religious areas as opposed to non-religious areas. This study also implies that political ads that aim to smear their opponents may not be effective in reducing contributions for their opponents. One hopes that this is true, as less smear advertising is surely better for modern politics.

CONCLUSION

The initial hypothesis going into this study was that, given the opportunity, religious donors would punish moral infractions of their political leaders through reducing donations. However, it must be concluded that this is surprisingly not the case. With the exception of sexual misconduct, which seems to be universally condemnable, other moral infractions appear to not have an effect on decreasing financial support. Not only is there insufficient evidence for a decrease in support, but it appears that religious donors actually double down and increase their donations in races that are especially competitive when there is an alleged misconduct. The diverse sample of Republican and Democratic politicians demonstrate that this holds true across party lines. It appears that the extent of media coverage and the existence of previous allegations are also possible factors at play here. Whether the alleged misconduct is interpreted as an unfortunate blemish on an otherwise suitable candidate, or as a political smear by the opposing party, religious donors appear to only be sensitive to moral infractions when allegations might harm the prospects of their preferred candidate winning the election.

ACKNOWLEDGMENTS

Written for Katherine Baldwin’s course, EPE 241: Religion and Politics, Fall Semester, 2020. Thank you, Professor Baldwin!

REFERENCES


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“In social science, one has to come up with ways of measuring events that are not necessarily reproducible.” Bradley Yam conducted research in his class “PLSC 415: Religion and Politics” and explored the ways in which moral issues affect how religious individuals donate politically. His Christian faith led him to a project where he could explore the intersections of his own identity as both a religious person and a student of political economy. Through his research, Yam sought to statistically explore whether religious individuals “withdraw their financial support from political candidates who display moral failures.” Rather than establishing a fixed plan for his research beforehand, Yam used this research as an opportunity to improve his skills in causal inference and working with big data in social science research; Yam analyzed over 26 million rows of political donations data!

Yam served as the editor in chief of The Yale Logos, a publication that seeks to sensitively engage issues that are important to Yalies from a Christian perspective. His involvement in The Yale Logos inspired Yam to explore publishing more broadly and to take classes such as the “ENGL 449: The Art of Editing.” As someone who is double majoring in Ethics, Politics, and Economics and Computer Science, Yam hopes to explore the intersections of the two disciplines. Yam also enjoys climbing at the local climbing gym and wrestling with the club wrestling team. Community has been “integral to [his] experience at Yale.” For example, Yam is a member of the Yale Students for Christ, which is a ministry for students to reflect on their own growth and experiences at Yale. As an international student from Singapore, Yam is also a member of the Malaysian and Singaporean Association (MASA), which builds community in more informal settings such as “inviting each other to [their] houses and enjoying Southeast Asian food.” Yam’s passion for community and his faith has evidently shaped his time at Yale into a fulfilling experience.

For the full-length profile, visit yalesymposia.com
A Dispersive Force Model of Caribbean Island Biogeography

Metabolic Control of Stem Cell Ageing and Longevity through Caloric Restriction

Examining the Viability of Computational Psychiatry: Approaches into the Future
A Dispersive Force Model of Caribbean Island Biogeography

By Anthony Sarkiss

Department of Ecology and Evolutionary Biology, Yale University

ABSTRACT

Framework-based models serve as an important tool to describe, predict and manage ecological systems. In this paper I construct one such model, a dispersive force model based on MacArthur and Wilson’s (1963) theory of island biogeography, in order to assess island species richness with varying climatic patterns. Specifically, I use island–mainland distance (d), insular area (A), a climatic dispersal parameter (f), and a climatic disturbance parameter (h) to calculate the insular species richness ratio at equilibrium. To test this model through hurricane impact on marine islands, it was executed with data from islands of the Dutch Caribbean. Future climatic conditions were based on the UN IPCC report’s 2100 predictions with a mean global temperature rise of 2°C. Although the model was implemented with conservative estimates, all the islands tested show a significant decline in species diversity in future climatic conditions. The windward islands show a ~9% to 13% decrease in insular species richness, compared to ~2% decline on the leeward islands.

INTRODUCTION

As efforts of ecosystem management become paramount, the study of macroecological patterns becomes increasingly important to recognize and better understand ecosystem composition and behavior as these ecosystems respond to climatic changes. In fact, “process-based models, using pre-existing ecological frameworks” have been observed as being “better to manage changing systems [compared to] purely statistical modeling,” especially when encountering changed conditions novel to the model (Cuddington et al., 2013). Therefore, there is a rising need to rethink traditional ecological frameworks to include factors that are significant to a changing climate and its impacts on the ecosystems in question. Theories of island biogeography fabricate one such field, where traditional frameworks work well in a descriptive sense, but they lack predictive power in terms of rapid climatic changes.

Island biogeography is particularly important to adapt to today’s conditions, given the prevalence of ecological islands in the world: marine islands, coral reefs, mountain ranges, and bacterial biomes associated with plant tissue are all examples of the widespread nature of ecological islands which humans are interested in studying, conserving, and managing (Peterson et al., 2008). And given the fact that islands have proven foundational for the study, formation, and improvement of ecological theory, they represent great candidates to further push theory along into an applied field (Hutchinson, 1961). Thus, I created a model which depends on traditionally accepted factors of island biogeography theory and also incorporated factors representing climatic events. In particular, I focused on the question of hurricane occurrence and species richness equilibrium on Caribbean islands. This focus is based on the legitimate concern for island ecological stability given modeled predictions of climate change, and on the gap that exists in observing island ecology as a function of discrete yet destructive climatic events, such as hurricanes (Pachauri et al., 2015). Additionally, Caribbean islands are relatively well-sampled in the ecological sense and well-studied in the meteorological and climatic sense, and the Caribbean is increasingly recognized as an important “biodiversity hotspot” on a global scale (UNEP).

Arguably the most well-known theory of island biogeography is the one produced by MacArthur and Wilson in 1963. At its core, its success lay in its observation of the impact of island area and distance from the mainland on the species richness of the island. Specifically, area is conceptualized to provide a saturation value of species richness, based on habitat abundance and heterogeneity: the larger the island, the greater the amount of species it can theoretically hold at an equilibrium state. Distance, on the other hand, modulates the present level of the island’s saturation value: the closer the island is to the mainland, the more saturated it is with different species. The area–richness relationship is based upon Preston’s species–area curve, whereas the distance-richness relationship is based on the probability of colonization over physical distances (MacArthur & Wilson, 1963; Preston, 1962).

Though newer models of biogeography have been proposed and discussed over the past few decades, none have managed to supersede the MacArthur-Wilson model. In fact, most popular and novel biogeography models build upon the theoretical foundations laid by MacArthur and Wilson. Of note is the general dynamic model (GDM), proposed by Whittaker, Triantis, and Ladle in 2008, which focuses on synthesizing the MacArthur-Wilson model with evolutionary and geologic processes, in order to capture biogeographic equilibria across larger timescales. Chen, Jiao, and Tong (2011) proposed a similar model, concerned primarily with incorporating speciation. Another branch of biogeography models maintains an interest in shorter (ecologically significant but geologically insignificant) timescales, attempting to add nuance by integrating key ecological frameworks. Gravel et al. (2011), for example, incorpo-
rate trophic levels and connectance as they build on top of MacArthur and Wilson’s basic framework.

With the understanding that the MacArthur-Wilson model remains foundational, and owing to the lack of established mathematical models for island biogeography that incorporate rapid climatic shifts, I began from the broad strokes they set in 1963. Adding onto the area- and distance-dependence of species richness, I deconstructed climatic events into two factors: that of dispersal and that of disturbance, with the understanding that different climatic events provide different magnitudes of dispersal and disturbance. Though speciation, glaciation, and many other factors can be implemented to better predict island biogeography patterns, given that this model is not to be used over geological timescales, these factors were not considered as significant (Rosindell & Phillimore, 2011).

Though the model presented below has the potential to be used as a stepping stone for more general models concerned with the impacts of climatic events on insular species richness, the immediate goal of this model was to predict the patterns of change in species richness equilibria across a variety of Caribbean islands. This goal was in hopes of better understanding the impact that the intensification, as well as the decrease in frequency, of hurricanes (as is expected based on climate models) will have on insular ecological health, based on the assumption that species richness and community diversity can act as proxy to broad ecological stability and health. (Bowker et al., 2008).

METHODS

Based on the MacArthur-Wilson model of island biogeography, I begin with the assumption that insular species richness is dependent upon the influx (immigration, colonization) of species from the mainland, along with the outflux (extinction) of species from the island in question (MacArthur & Wilson 1963). Colonization (\( \lambda \)) is based on a function of the island’s distance from the mainland, as well as a function corresponding to the dispersive force that the island experiences based on climatic events. On the other hand, Extinction (\( \mu \)) is based on a function of the island’s area, as well as the disturbance that the island experiences based on climatic events.

\[
\lambda(S) = f(\text{distance, dispersal}) \quad \quad \quad \quad \mu(S) = f(\text{area, disturbance})
\]

Distance and dispersal are forces that work in tandem, influencing and modulating one another. This is based on the rationale that colonization is fundamentally an act of dispersal over a certain distance. As such, longer distance makes dispersal less likely, and lower dispersal makes colonization less likely even at a short distance. The functions of dispersal and distance are thus multiplied through an ‘and-gate.’ The functions of area and disturbance, however, are interpreted as independent and additive functions that are related through an ‘or-gate.’ Accordingly, extinction may be conceptualized as two independent fluxes operating upon the same insular species pool: the area function portrays the possibility of species extinction through resource scarcity or niche exclusion, as both mechanisms are likelier on islands of smaller area. In contrast, climatic disturbance stands as a secondary channel of species extinction, by which climatic events, through their magnitude or frequency, may disturb populations (through drastic reductions in generational survivorship, for example) to the point that they cannot recover.

Through the understanding above, the following diagram may be used as the basis of the model:

Note that \( S \) is the variable representing insular species richness as a proportion of the species on the mainland that are present on the island. In other words, \( S = \frac{\text{island } \alpha - \text{diversity}}{\text{mainland } \alpha - \text{diversity}}, \) with a value between (0, 1).

This model’s construction implicitly assumes that the mainland species are adapted to a variety of climatic conditions, and that climatic events impacting the islands will not have a significant effect on mainland species richness, \( P \). Additionally, no change in climatic stochasticity is assumed, and colonization from neighboring islands (internal colonization) is not considered. The dispersive and disturbance forces are also assumed to hold constant for multi-year periods, as new species richness equilibria are reached.

FUNCTION CONSTRUCTION: COLONIZATION

Colonization is inversely related to distance, as farther distances lead to increasingly slimmer chances of new species arrival from the mainland. Therefore, as the distance-based parameter \( d \) increases, the rate of colonization at a given value of insular species richness decreases. \( d \) is determined such as \( d = \frac{1}{(1, 10)} \), where \( d = 1 \) signifies no distance (that the island is in fact part of the mainland) and \( d = 10 \) signifies maximum distance, beyond the scope of the data represented. This parameter is linearly correlated to distance.

The rate of colonization, as based on distance, is also linearly dependent on the species richness proportion, \( S \), already present on the island. This implicitly accounts for the fact that as more species are present on the island, there is higher chance that an invading species might not become successfully established, based on competition and limited insular resources. The dependence of the rate of colonization on insular species richness also accounts for the fact that as more species are present on the island, it is statistically less likely that a newly invading organism will be a new species (in other words, this ‘rescue effect’ is implicit in the model). Mathematically, this translates to:

\[
\lambda_d(S) = \frac{1}{d} - \frac{S(t)}{d}
\]
The climatic event-driven dispersal onto an island, related by the parameter \( f \), is described as a Holling type II functional response, (Holling & Buckingham, 1976), in light of the saturating effect that increases in storm magnitude or frequency lead to. An incremental increase in dispersal force, therefore, is assumed to contribute less colonization per unit of dispersal force. The summand \((=1)\) in the denominator was chosen to constrict most of the change attributable to \( f \) to an \( S \)-value between \((0, \, 1)\).

\[
\lambda_f(S) = \frac{f}{f + 1}
\]

\( f \), which stands between \((0, \, 10)\), is calculated for hurricanes as follows. Island hurricane and tropical storm occurrences are counted and tabulated according to the Simpson-Saffir Hurricane Wind Scale (SSHWS), for the decades between 1980 and 2020 (NOAA, 2019). Decadal frequency is calculated as the sum of all storm events for the decade, and decadal intensity is calculated as a weighted average of the decade’s storm events, based on Table 1. With decadal frequency and intensity values acquired, the decade’s dispersal force value, \( f \), is calculated by multiplying the above two values. Ultimately, averaging the four decades’ dispersal parameter values provides a value more representative of the island’s true modern history.

<table>
<thead>
<tr>
<th>SSHWS Category</th>
<th>Wind speed relative to Cat. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical storm</td>
<td>0.28x</td>
</tr>
<tr>
<td>Category 1</td>
<td>1x</td>
</tr>
<tr>
<td>Category 2</td>
<td>1.7x</td>
</tr>
<tr>
<td>Category 3</td>
<td>3.1x</td>
</tr>
<tr>
<td>Category 4</td>
<td>4.5x</td>
</tr>
</tbody>
</table>


**EXTINCTION**

As described by the MacArthur-Wilson model, increasing insular area allows for the island to saturate at a higher species richness. Ecologically, this relates to more abundant resources and increasingly heterogeneous habitats, both leading to higher levels of coexistence and niche partitioning. Therefore, as the island area-based parameter \((A)\) increases, the rate of extinction at a given value of insular species richness decreases.

The parameter \( A \) is calculated based on the species-area curve, as posited by Preston in 1962. Preston’s observations showed a logarithmic relationship between island area and insular species richness, characterized by the relationship \( S = cR^{b} \), where \( S \) is the insular species richness, \( R \) is the island area, and \( c \) and \( z \) are empirically-derived constants. According to this relationship, the island area-based parameter \( A = \frac{cR_{\text{land}}}{cR_{\text{max}}} \).

Paralleling the relationship between colonization and distance, the rate of extinction, as based on area, is linearly dependent on \( S \), the species richness proportion. Ecologically, this is attributable once more to competition and resource availability: higher alpha diversity on the island leads to higher levels of competition for the same resources, which leads to higher levels of extinction. Thus, the function relating the rate of extinction to area is as follows:

\[
\mu_A(S) = \frac{S}{A}
\]

The extinction-driving counterpart to climatic event-driven dispersal is disturbance, as large climatic event types are assumed to provide an opportunity for species dispersal as well as an opportunity for extinction through disturbance. The disturbance parameter \( h \) is described as a Holling type III function, thus proposing a sigmoid relationship between disturbance and extinction: low levels of disturbance are not expected to contribute much, if at all, to extinction. On the other hand, moderate levels of disturbance might lead to more significant rates of extinction, as the climate event would be harsh enough to lead to collapse in certain communities. There is an expected saturating effect at high levels of disturbance, as communities that are susceptible to the specific climatic event considered would collapse, but no further damage would occur to more resilient communities. Thus, the function is related as follows:

\[
\mu_h(S) = \frac{h^2}{h^2 + 1} - 1
\]

Like the dispersal parameter \( f \), \( h \) is a number between \((0, \, 10)\), and it is calculated as dependent on \( f \). The ratio between \( f \) and \( h \) is to be estimated for each climatic event considered. Considering hurricanes’ relatively higher level of dispersal than disturbance, \( h = \frac{f}{2} \) was initially assumed.

Following original model assumptions of \( \frac{dS}{dt} = (\lambda_f(S)) - (\mu_A(S) + \mu_h(S)) \), the model is mathematically described below. Parameter and variables constraints are listed in Table 2.

\[
\frac{dS}{dt} = a \left(1 - \frac{S(t)}{A}\right) \left(\frac{f}{f + 1}\right) - \beta S(t) - \frac{\gamma}{h^2 + 1} - 1
\]

Table 2. Summary of parameters and variables.

The floating parameters \( a \), \( \beta \), and \( \gamma \) are multiplied by each of the three resulting polynomials that comprise the differential equation above, in order to best fit model predictions to actual data. Floating parameter values were calculated by transforming the equation according to the understanding that \( S_0 = \frac{\bar{S}}{\bar{x}} \), and finding values of \( a \), \( \beta \), and \( \gamma \) that minimized the least squares sum of the resulting equation \( \sum (S_i - \sigma_i)^2 = f(\Gamma, B) \). \( \bar{S} \) represents predicted species richness at equilibrium, \( \sigma \) represents the actual observed species richness, \( \Gamma \) represents the floating parameters \( \bar{a} \), and \( B \) represents the floating parameters \( \bar{b} \).
DATASET CONSTRUCTION

Focusing on marine islands impacted by hurricanes, data was compiled on the Dutch Caribbean islands of Aruba, Bonaire (and Klein Bonaire), Curaçao (and Klein Curaçao), Saba, St. Eustatius, and St. Maarten in order to test the model against a realistic scenario. They are represented in the map in Figure 1. These islands were specifically selected because of the consistent biodiversity data present in each of them, and because of the islands’ variability in their tendency to experience hurricanes. Insular species richness was compiled from the Naturalis Biodiversity Center’s Dutch Caribbean Species Register (dutchcaribbean.species.org); unicellular and aquatic species were excluded from the search. Additionally, Google Maps was used to measure island area and distance from the mainland, where the mainland is assumed to be South America for all the islands. It is noteworthy that northern South America’s total species richness is yet unknown, but an estimate of $P = 100,000$ was deemed appropriate based on world terrestrial multicellular species richness estimates (Caley et al., 2014). Dispersal and disturbance parameters ($f$ and $h$) were calculated according to data found on the Caribbean Hurricane Network’s Climatology of Caribbean Hurricanes, for each specific island (stormcarib.com). The dataset thus compiled on the Dutch Caribbean islands is presented in Table 3.

FUTURE CONDITIONS

In order to model future species richness on the islands in question, it is necessary to calculate new dispersal and disturbance parameters for the islands in a future scenario. The future time period referenced throughout this paper is conceptualized as the year 2100 with a 2°C mean global temperature rise from 2000, based on the Intergovernmental Panel on Climate Change’s fifth synthesis report (Pachauri et al., 2015). In this scenario, hurricanes and other tropical cyclones are expected to increase in intensity by 2-11%, while frequency is expected to decrease by 6-34%. There is “less confidence in future projections” of the latter metric. (Knutson et al., 2010; NOAA, 2020) Precipitation rates associated with hurricanes are expected to increase ~15% (Pachauri et al., 2015). Predictions in this paper are calculated based on the greatest percentage change in intensity and a 6% decrease in frequency. The projected increased precipitation rate is not considered within the dispersal or disturbance parameters, as the measurement is relatively fine-grained.

Model construction and implementation and plot output was executed through R (v4.0.3), utilizing the ‘deSolve’ package for ordinary differential equation calculations and the ‘ggplot2’ package for graphics creation. Least square minimization was performed through the ‘optim()’ function, optimizing through the Nelder-Mead algorithm.

RESULTS

Adjusting the floating parameters to best fit the model to the observed data presented, the parameters’ values were calculated as follows: $\alpha = 10$, $\beta = 5755.59$, and $\gamma = 9.85$, resulting in the following equation:
The behavior of species richness proportion is observed over time, starting at different initial states, and given identical parameters, each trial approaches the same equilibrium. In this case, parameters are \( d = 9 \), \( A = 1 \), \( f = 1.2 \), and \( h = 0.6 \).

\[
\frac{dS}{dt} = 10 \left( \frac{1}{d} - \frac{S(t)}{d} \right) \left( \frac{f}{f + 1} \right) - 5755.59 \left( \frac{S(t)}{A} \right) - 9.85 \left( \frac{h^2}{h^2 + 1} - 1 \right)
\]

The behavior of species richness proportion is observed over time (\( S \sim t \)), reaching equilibrium starting at multiple initial states in Figure 2. Initial state is shown to have no effect on the ultimate equilibrium species richness proportion of the island in question. Even a hitherto uncolonized island (\( S_{\text{initial}} = 0 \)) approaches the same expected equilibrium as previously colonized islands of identical parameters.

Using the dataset presented in Table 3, predicted species richness at equilibrium (\( S \)) is plotted against the observed species richness of the islands (\( \bar{s} \)) in Figure 3. Though predicted values consistently fall within the same range as the observed values, it is of note that the three islands of Saba, St. Eustatius, and St. Maarten are predicted to have much scarcer species richness than they do, and this is potentially owing to their significantly different climate patterns than the rest of the islands. Whereas the other islands considered are tropical arid, Saba, St. Eustatius, and St. Maarten are dominated by tropical rainforests. Removing the three islands’ data points from analysis, \( R^2 \) increases from 0.09 to 0.84. Nevertheless, scalar corrections between the observed and predicted values are presented in Table 4.

Table 4. Scalar corrections between observed and modeled insular species richness proportion.

<table>
<thead>
<tr>
<th>Island</th>
<th>Modeled value</th>
<th>Scalar correction</th>
<th>Observed value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aruba</td>
<td>0.003151578</td>
<td>2.83350119</td>
<td>0.00893</td>
</tr>
<tr>
<td>Bonaire</td>
<td>0.006689898</td>
<td>1.33335366</td>
<td>0.00892</td>
</tr>
<tr>
<td>Klein Bonaire</td>
<td>0.000002769</td>
<td>176.959191</td>
<td>0.00049</td>
</tr>
<tr>
<td>Curaçao</td>
<td>0.015542120</td>
<td>0.94324326</td>
<td>0.01466</td>
</tr>
<tr>
<td>Klein Curaçao</td>
<td>0.000002229</td>
<td>2096.06987</td>
<td>0.00048</td>
</tr>
<tr>
<td>Saba</td>
<td>0.000002111</td>
<td>7787.7783</td>
<td>0.01644</td>
</tr>
<tr>
<td>St. Eustatius</td>
<td>0.000006110</td>
<td>2317.51227</td>
<td>0.01416</td>
</tr>
<tr>
<td>St. Maarten</td>
<td>0.000014322</td>
<td>890.238793</td>
<td>0.01275</td>
</tr>
</tbody>
</table>

Table 5. Expected changes in species richness based on dispersive model predictions. Note: Numbers in “predicted future richness (s)” column are rounded up to the nearest unit.

<table>
<thead>
<tr>
<th>Island</th>
<th>Present observed richness (s)</th>
<th>Predicted future richness (s)</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aruba</td>
<td>895</td>
<td>874</td>
<td>-2.15%</td>
</tr>
<tr>
<td>Bonaire</td>
<td>892</td>
<td>874</td>
<td>-2.08%</td>
</tr>
<tr>
<td>Klein Bonaire</td>
<td>49</td>
<td>48</td>
<td>-2.11%</td>
</tr>
<tr>
<td>Curaçao</td>
<td>1466</td>
<td>1437</td>
<td>-1.99%</td>
</tr>
<tr>
<td>Klein Curaçao</td>
<td>48</td>
<td>47</td>
<td>-1.97%</td>
</tr>
<tr>
<td>Saba</td>
<td>1644</td>
<td>1463</td>
<td>-11.02%</td>
</tr>
<tr>
<td>St. Eustatius</td>
<td>1416</td>
<td>1239</td>
<td>-12.46%</td>
</tr>
<tr>
<td>St. Maarten</td>
<td>1275</td>
<td>1152</td>
<td>-9.63%</td>
</tr>
</tbody>
</table>

After the application of future climate condition parameters to each island, the insular species richness proportion of the islands are plotted in present and future condition in Figure 4. Owing to the islands’ small size, Klein Bonaire, Klein Curaçao, Saba, St. Eustatius, and St. Maarten are plotted once more below the main plot in Figure 4, each to an appropriate scale. The islands uniformly experience a decrease in species richness under future conditions. The model’s predictions are corrected and reverted from proportion to absolute richness, leading to the actual decrease in species number expected on each island, as presented in Table 5. The islands more sheltered from hurricanes in the present (Aruba, (Klein) Bonaire, (Klein) Curaçao) are predicted to experience a decrease of ~2% in species richness, whereas the islands that are presently more exposed (Saba, St. Eustatius, St. Maarten) are expected to experience ~9-13% decrease in species richness, leading to predictions of significantly greater alpha diversity loss on the latter islands.
DISCUSSION

It is of note that the model as constructed presents a relationship between the scalar correction factors and island size. The scalar correction factors, used to equate the model predictions to observed data, generally decreased with increasing island area, as presented in Figure 5. This indicates that larger island sizes produce smaller discrepancies between model results and observed data, requiring less correction. This discrepancy may further support a behavioral devolution into chaos within the system, once a small enough island area threshold is crossed.

Observing future species richness equilibrium predictions (Figure 4, Table 5), in tandem with the current understanding of global climate change patterns, it is unsurprising that islands are expected to see a significant decrease in species richness. It is apparent that Saba, St. Eustatius, and St. Maarten are expected to experience a greater loss in diversity. This may be best explained through these islands' geographic location in relation to the hurricane belt (the general trajectory of North Atlantic hurricanes): the islands fall within this hurricane belt, leading to larger climate-mediated hurricane effects on the islands. In other words, the fact that these islands experience more hurricanes signifies their increased sensitivity to a change in hurricane disturbance levels ($h$).

Moreover, the similar trends of sharp decline on the three islands may be further explained through the saturating effect of the dispersive parameter, $f$, and the sigmoid function of the disturbance parameter, $h$. Seeing as \( \frac{ds}{dt} = \frac{f}{f+1} \) and \( \frac{ds}{dt} = -\frac{1}{h^2+1} \), and holding $h = \frac{f}{2}$ constant, as has been assumed throughout this paper, the interactions of these two parameters leads to the following trend:

\[
5 \sim \frac{f}{f+1} + \frac{1}{(\frac{f}{2})^2 + 1}
\]

The trend above produces a curve with a local maximum, which suggests that, at certain $f$ and $h$ values, species richness increases before decreasing significantly. Because the islands of Saba, St. Eustatius, and St. Maarten have higher dispersal and disturbance parameter values than the rest of the islands, they may be closer to this species richness maximum in present conditions (see Figure 6). These values, along with the islands' wetter and more forested habitats, may explain their high species richness numbers. Moreover, the islands’ sharp decline in species richness, as predicted for future conditions, is best conceptualized through being pushed beyond the curve’s maximum.

As described above, the islands of Saba, St. Eustatius, and St. Maarten showed a large discrepancy in real versus modeled values of insular species richness. This discrepancy may be best attributed to the islands’ wetter climate, leading to the need for differential calibration of the floating parameters $\alpha$, $\beta$, and $\gamma$ based on these islands significantly different macrobiotic regime. Additionally, the islands’ location within the Lesser Antillean chain of islands puts them in close proximity to insular sources of colonization, otherwise known as internal colonization, which had been excluded from this model. The importance of internal colonization is empirically supported by several examples—for instance, the presence of a ring species complex in *Euphorbia tithymaloides* (order: Malpighiales), solidifying through evolutionary diversification the island-to-neighboring-island colonization pathway in the Caribbean (Cacho & Baum, 2012).

In contrast to Saba, St. Eustatius, and St. Maarten’s higher hurricane frequency, the islands of Aruba, (Klein) Bonaire, and (Klein)
Curaçao, are situated at relatively safe geographic locations in terms of hurricane probability. As such, even with the same percent increase in hurricane intensity, and with the same percent decrease in hurricane frequency, these islands are not predicted to suffer diversity losses comparable to the former group of islands.

Although the predictions described in the result section above prove helpful for understanding the patterns of species richness change in a future scenario with more intense and less frequent hurricanes, these results may be far too conservative. As significant sea level rise and an increase of up to 20% in hurricane-associated precipitation is expected by the year 2100, permanent and seasonal inundation may leave current terrestrial habitats decimated (GFDL, 2020; Knutson et al., 2010; Pachauri et al., 2015). Additionally, changes in weather patterns and increased air temperatures may further worsen the effect. To account for these changes, more realistic future predictions would increase the disturbance parameter \( h \) at a much higher rate than the dispersal parameter \( f \), instead of maintaining a constant relationship \( h = f^2 \).

Process-based mathematical models, such as the one presented in this paper, may prove useful or even crucial in better assessing and managing ecosystem resources in the future (Cuddington et al., 2013). Nevertheless, hurricanes (and climatic events in general) produce significantly different effects based on the organism, ecosystem, or island in question (Tanner et al., 1991). Thus, general biogeographic models in this vein cannot be exact, yet their generalist nature can guide the user to larger and more coarse-grained patterns that are helpful in their very lack of specificity.

Moreover, the dispersive force model presented above has great applicability in answering questions of biogeography concerning other ecological islands. With the understanding that hurricanes represent one example of climatic events, future directions would entail constructing a system to measure and categorize disturbance and dispersal magnitudes across different types of climatic events (e.g., wildfires, tornadoes, marine currents, floods, etc.), based on their respective frequencies and intensities, in order to study the biogeographic effects of climatic events in other island systems, including montane islands, reefs, and bodies of water.

**REFERENCES**


Anthony Sarkiss is fascinated by connection and change: the connections between the small and large, from molecular biology to biospheric data, and systems thinking, determining the ecological drivers of change and locating areas of resistance. A senior E&EB major in Pauli Murray College, Sarkiss is a certified scuba diver and has conducted research since the summer of his first year at Yale—first in the Jacob Lab and now the Edwards Lab.

Sarkiss became interested in ecology when he was in high school, having spent time working in a botanical garden and participating in his school’s scuba club. He was involved with the Surfrider Foundation in Miami, where he calls home, contributing to dune and coral restoration efforts. At Yale, Sarkiss has both volunteered and worked for the Marsh Botanic Gardens greenhouse since his first year, in addition to being a member of the Community Health Educators and the Arab Students Association.

Sarkiss has immersed himself in research not only in the classroom—by taking field-based classes, studying local forests and lakes in Connecticut—but also by working in the lab. As the only undergraduate student to enroll in the graduate course “Mathematical Models and Quantitative Methods in Evolution and Ecology,” Sarkiss was initially wary, yet also excited by the freedom he found in shaping his studies. Whereas graduate students used the class to build models related to their own interests, Sarkiss did not have any particular question or area of study on which he sought to focus; he simply “picked a cool question and was able to run with it.” Sarkiss was then able to study the effects of climate change—in particular, of hurricane frequency and intensity—on species richness and diversity in ecological islands in the Caribbean, after having created a model in this graduate course. Enrolling in a graduate-level class as an undergraduate really served to demystify the experience for him, as it was not as daunting as he had initially thought.

Sarkiss has found guidance, support, and open communication channels every step of the way in his research work, and his experience in the lab has shown just how much his interests in biology hold true. There is a difficulty inherent in the interdisciplinary biology he has aspired to study as an undergraduate student, especially in how the departments are split up, making it tougher to answer the questions that he seeks to pose. Not a “lake person” or “bird person,” he hopes to take some time off after graduating in the spring in search of something that will best match his interests.

For the full-length profile, visit yalesymposia.com
The brushstroke is inherently rebellious. In a world that denounces and diminishes art, the artist is a protester. And in a world that silences the voices of black individuals, the protester is an artist. In this image, which signifies how integral art was in the Black Lives Matter movement in Richmond, Virginia, paint drips down to a statue of Robert E. Lee. This Confederate monument, through art, was both rejected and reclaimed to fortify the Black Lives Matter movement, and the dripping paint serves to stain and challenge its racist legacy. To represent the complexity of art and rebellion referenced in the paper, I included graffiti, written messages, protests, paint, fists, projections, and tattoos. I believe that there is beauty in abstraction, but there is also power in lucidity, in a sharp voice screaming “No Justice! No Peace!” and the unapologetic affirmation that black lives matter.

Based on the abstract from: “Art as Protest: How Creative Activism Shaped ‘Black Lives Matter’ in Richmond, Virginia”

I photographed a flower of the passiflora, a family native to the Dutch Carribean—the area from which data was collected for the dispersive force model in the article. As these islands face a tragic predicted decline in biodiversity, according to the UN IPCC report’s predictions mentioned in the article, it is important to appreciate the beauty of the ecological systems on these islands. We also must acknowledge the responsibility that we have in protecting the ecosystems of the Dutch Carribean islands, among any other biosystems threatened by human development, and actively solve the problems we create for the environment.

Based on the abstract from: “A Dispersive Force Model of Caribbean Island Biogeography”

My cover design plays with the idea of marionettes as it features in the article. The author studies John Singer Sargent’s painting Marionettes through the lens of the puppeteer boys, not the puppets. They explore how social performativity and adolescent freedom (or the lack thereof) shaped Edwardian childhoods. My illustration casts Edwardian-era boys as marionettes themselves, reflecting the idea of freedom and illusions of freedom—the marionette appears to move naturally, but it is really controlled by a puppeteer. The puppet strings are like the norms of class, gender, and sexuality at the time. Additionally, the harsh stage lighting emphasizes the idea of performativity as a driving force in adolescence. The somewhat disturbing fantastical nature of human marionettes highlights how childhood in the Victorian and Edwardian eras was not a time of complete innocence.

Based on the abstract from: “Performance and Fantasy in Edwardian Childhood: Representations of Class, Gender, and Education”
ABSTRACT

As modern medicine becomes increasingly personalized, psychiatry lags behind, using poorly-understood drugs and therapies to treat mental disorders. With the advent of methods that capture large quantities of data, such as genome-wide analyses or fMRI, machine learning (ML) approaches have become prominent in neuroscience. This is promising for studying the brain’s function, but perhaps more importantly, these techniques can potentially predict the onset of disorder and treatment response. Experimental approaches that use naive machine learning algorithms have dominated research in computational psychiatry over the past decade. In a critical review and analysis, I argue that biologically realistic approaches will be more effective in clinical practice, and research trends should reflect this. Hybrid models are considered, and a brief case study on major depressive disorder is presented. Finally, I propose a novel four-step approach for the future implementation of computational methods in psychiatric clinics.

INTRODUCTION

Psychiatrists traditionally utilize behavior and psychology in the clinic but have long sought to ground the practice in biology. Unfortunately, contemporary research has yet to translate, due to the inevitable truth that the brain cannot be carved at its joints. This means that enormous neural complexity has prevented modern methods from sufficiently elucidating pathophysiological processes. Similarly, the conceptual bridges between cellular biology, systems neuroscience, and behavior are shaky given the limits of neuroscientific theory as well as data collection capabilities.

There exist only a handful of mechanistic theories of dysfunction in mental illness, such as the dopamine or glutamate hypothesis in schizophrenia (Seeman, 1987; Gordon, 2010). These first steps have refuted the contemporary understanding disorders as having one-to-one biological mappings. The practical conception of disorder is defined in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-V; American Psychiatric Association, 2013) on the basis of symptom presentation. This is likely incorrect for a few reasons. First, a DSM-V disorder might encapsulate subtypes with varying etiologies. Second, the prevalence of comorbidities such as depression and anxiety (according to Brady et al., 1992, almost 62%) likely indicates overlapping or interacting neural correlates of various pathologies. Pervasive comorbidity and heterogeneity in psychologically-defined disorders have provoked the Research Domain Criteria (RDoC) approach, which seeks to rebuild psychiatric disorders from biology upwards (Insel et al., 2010).

Neuroscience faces an accelerating deluge of information which analytic trends have not reflected. Imaging studies often fail to replicate (Jahanshad, 2019). A common concern has been limited sample size; open-source initiatives seek to mitigate this issue by sharing data (Poldrack & Gorgolewski, 2019). Data preprocessing techniques in fMRI vary between sites, which have significant influence on results (Smith & Nichols, 2018). Additionally, statistical techniques used in much of neuroscience are simply out of date. Linear models are interpretable, but neural systems are highly non-linear and analyses should reflect this (Friston, 2004).

In this paper, I analyze the effectiveness of computational tools for clinical psychiatry research and practice. Although the clinical implementation of these methods is the ultimate goal, I seek to examine the viability of computational psychiatry as a research method for developing precision psychiatry. This is not to say that we cannot examine how they might fit into the clinic itself. The beauty of these tools is that they can often be used predictively and to generate understanding, allowing for usage in both research and practice. However, the field is a long way from success in either domain. Thus, I seek to provide a comprehensive review of computational methods applied to psychiatry in general in the hopes of providing a clearer picture about where the field is headed.

BRIEFLY: WHAT IS COMPUTATIONAL PSYCHIATRY?

Computational psychiatry as a discipline is divided into theory- and data-driven approaches (Huys et al., 2016). Theory-driven approaches model the biological processes that generate dysfunction, whereas data-driven models remain agnostic to underlying causes, utilizing statistical trends in data to make inferences on new samples (Bennet et al., 2019). Montague et al. (2012) define a framework for five subdomains: a) data-mining, modeling and phenotyping, b) producing new biological hypotheses, c) large-scale data
sharing, d) biomarker discovery, and e) application to therapeutics. Data-driven models often utilize supervised ML methods, which have the goal of predicting labels from labelled data (Shatte et al., 2019). Another type, unsupervised learning, extracts statistical patterns from data. Principal component analysis, a linear technique that reduces the dimensions of data into sub-components, is popular due to its interpretability (Drysdale et al., 2017; Bondar et al., 2020). In theoretical work, researchers seek to infer cognitive or neurological states from behavior or neuroimaging. Models, such as dynamic causal models (see Theoretical Approaches) seek to represent disorder of biophysical processes and are often utilized in conjunction with neuroimaging (Friston et al., 2017).

The bridge across the chasm between computational psychiatry research and the clinic is neither stable nor complete. In this analogy, theory-driven approaches might be the slow yet precise construction of an overpass, whereas data-driven approaches are a ramp to facilitate a motorcycle jump, Evil Knievel-style. The latter method is faster, but risk and uncertainty are significantly higher as they do not refer to any underlying disorder. Additionally, data-driven approaches are plagued with poor methodology (Rutledge et al., 2019).

Computational approaches can be quite relevant to some psychiatry work (Chekroud et al., 2017), for example in predicting the risk of a patient experiencing their first psychotic episode (Koutsouleris et al., 2016; Adams et al., 2016) or categorizing prognosis (Kessler et al., 2016). Other types of predictions include finding best possible treatment for a set of symptoms (Paulus & Thompson, 2019), forecasting treatment response (Webb et al., 2018), or making diagnoses (Kalmady et al., 2019; Hahn et al., 2020). Unsupervised approaches can find new endophenotypes of a disorder that might cause variation in therapeutic responses (Drysdale et al., 2017; Chand et al., 2020).

In the face of overwhelming data, choosing the correct approach is crucial. To develop clinically effective systems, all relevant data should be considered, including electronic health records, -omics, imaging, internet activity, and more. The abundance of data can introduce corrupting noise, which necessitates statistical techniques to enhance signal. Furthermore, contemporary databases tend to skew towards specific populations, such as white men or UK citizens, which must be corrected (Monteith et al., 2015). Finally, data privacy is of utmost concern.

WHY HAS COMPUTATIONAL PSYCHIATRY NOT YET TRANSLATED TO CLINICAL PRACTICE?

In other medicines, computational approaches are flourishing, for example in classifying the presence of cancer (Yoo et al., 2019). Deep learning (see Theoretical Approaches for a brief explanation) to classify diabetic retinopathy has entered clinical trials (Rajalakshmi, 2020). However, psychiatric data are often not as straightforward, given their neurological complexity, subjective nature of experience, and clinical heterogeneity.

While numerous studies have demonstrated the impressive capability of these systems, they maintain insufficient generalizability, such that clinicians have not adopted or even tested them in randomized clinical trials (Woo et al., 2017). While clinical psychiatry itself is imperfect, occasionally prescribing drugs through trial and error, which risks long-term side effects, replacing this with a similarly erroneous system is illogical and expensive (Chekroud & Koutsouleris, 2017). Until computational psychiatry can create useful solutions, it will remain out of the clinic.

It should be noted that the methods themselves are novel. Neuroimaging is both time consuming and expensive (Vu et al., 2018, Chandler et al., 2019). The shift in perspective of fMRI studies from functional region to whole-brain approaches (Richiardi, 2013) emphasizes that a stronger understanding of neural computation is necessary for selecting both methods and relevant data in research. Neuroimaging has proved especially difficult in the search for biomarkers—Dwyer et al. (2018) notes that fMRI studies utilizing classical statistics have a 70% false positive rate, meaning that experiments will find a statistically significant correlation in the data more often than not, even if none is truly there. Similarly, current treatment-predictive models do not incorporate the ability to select multiple therapies, a regular practice in the clinic.

Woo et al. (2016) emphasizes that most computational methods for psychiatry remain in the research stages of development. Yet data-driven approaches have often outmatched clinical counterparts in various clinically-relevant tasks (Bzdok & Meyer-Lindenberg, 2018). So why are these results insufficient to be instantiated in hospitals? It should be noted that most disorders lie in some abstract symptom space where different medical parameters define the dimensions, and an expert-defined decision boundary, which classifies data points based on their location relative to the boundary, determines diagnosis. Samples near the boundary will be difficult to classify, especially if we do not understand the nature of the disease. In these cases, which are frequent, naive approaches might not work as desired, leading to poor generalization among patient types (Schultze-Lutter et al., 2018). Yet some models have found relative success, such as Chekroud et al. (2017) which found three generalizable symptom clusters in the Sequenced Treatment Alternatives to Relieve Depression (STAR*D) dataset (MDD, n = 4039) that characterized antidepressant responsiveness.

FAILURE TO REPLICATE

Neuroimaging studies tend to overfit, or fail to generalize beyond, the experimental data. These studies suffer from the curse of dimensionality due to the small sample size. As described by Huys et al. (2016), when the number of features exceeds the number of samples, it is possible to perfectly distinguish n patients from m controls by using n+m-1 features. Functional connectivity matrices, which measure in fMRI how the changes in activity of one brain region correlates with the changes in another, often have close to 100,000 features per data point, while sample sizes are minimal, with close to 100 subjects (Venkatesh et al., 2020). Utilizing a region of interest approach, which focuses on a particular location of the brain, reduces dimensions drastically. Increasing the size of datasets or selecting meaningful features via regularization tech-
niques or theory could further mitigate these issues (Huys et al., 2016).

As mentioned previously, psychiatric data is noisy. Approaches that focus on diagnosis directly from data, such as Zhu et al. (2018), suffer from high rates of misclassifications (Chekroud, 2017) and do not exceed clinical accuracies as they still utilize the DSM-V criteria. Biomarkers might be shared across disorders when these definitions are used, further confounding separability (Fernandes & Berk, 2017).

Commonly used algorithms cannot represent the complex relationships required in psychiatry. Powerful methods such as deep learning have been examined but only as proof-of-concept (Durstewitz et al., 2019; He et al., 2020). Additionally, common optimization techniques such as feature selection, which selects variables based on how much they improve a model, can have detrimental effects when attempting to generalize to new populations (Paulus et al., 2019).

However, the key problem behind data-driven failures is that their methods do not take into account the temporality and plasticity of mental illness. These models capture a snapshot of the clinical picture, abstracting away the dynamics of neurological function. Thus, despite trends towards best practices, they will likely fail to ultimately reach the acceptable threshold of generalizability for clinical usage alone.

**CURRENT TRENDS**

The two obvious solutions to the major problems (limited data and lack of generalizability) are currently being addressed by open-source projects, triggering an upward trend in sample size. The community has responded via initiatives such as the Human Brain Project and the Human Connectome Project, which have collected large databases of fMRI recordings from thousands of people (Vu et al., 2018). These projects are an excellent step in the right direction, and have yielded significant findings in basic neuroscience research. However, scientists seeking to use the data for clinical research continue to be wary of these sample sizes, as well as the fact that the data regularly comes from one source, which can increase bias (Smith & Nichols 2018). He et al. (2020) found that increasing the sample size on a behavioral and demographic classification task from 100 subjects to 8000 improved the correlation of predicted and ground truth labels from <0.05 to 0.25, a promising increase. Similarly, Hahn et al. (2020) utilized data from 27 recording sites provided by the ENIGMA Addiction working group, which limits single-site bias.

Yet these are often not enough. Drysdale et al. (2017) found two clusters of depression with different symptom profiles based on resting state fMRI that offered separable clinical symptom profiles and differential treatment responses to Transcranial Magnetic Stimulation on 1,188 training samples over multiple sites. Despite these precautions, the study failed to replicate (Chekroud 2020, personal correspondence). If computational methods cannot satisfy the robustness criteria of research, how can we hope to integrate them in practice?

As studies move into clinical testing, they will need even more rigorous standards of validation. Algorithms will need to display reliability (performing adequately for long periods of time), scalability (increasing production and distribution to customers), and ease of implementation (allowing non-experts to utilize the technology) (Nair et al., 2020) via clinical trials. Paulus et al. (2016) detail a prospective pipeline, with phases requiring robustness, clinical validity, efficacy in a randomized clinical trial, clinical effectiveness, and post-marketing refinement. Five years later, no method has passed phase one. What further changes could facilitate progress? To develop a robust predictive or explanatory model of mental health disorders, data should be used in the same way as psychiatrists. Clinicians take the past into account via patient histories, and so too should computational systems (Stiefel et al., 2019). Second, increased emphasis should be placed on theory-based research, as models derived from theory are more likely to generalize and potentially lead to clinically-relevant findings (Huys et al., 2016). While machine learning is effective at tasks such as image recognition (Kirzhensky et al., 2012), these are not as complex as psychiatry or neuroscience. An informed approach is paramount.

This is not to say that the data-driven research should be abandoned entirely. Rather, it will have a position in clinical practice, perhaps as a first pass system (see my four-step proposal), while the more neuroscientifically-grounded models will further the analysis. Woo et al. (2017) note that the majority (75%) of neuroimaging studies that search for biomarkers for disorder apply a data-driven approach, underscoring the community’s excitement towards ML, but excitement is not enough. Similarly, the weak explanatory power of genomics or neuroimaging is not enough to directly prove informative or clinically efficacious (Chekroud, 2018).

**THEORETICAL APPROACHES**

Theory-driven models draw upon decades of neuroscience (Flagel et al., 2019). They include biophysical simulations and behavioral models in varying degrees of precision. They can account for heterogeneity in standard pathophysiology by adjusting various pieces of a generalized framework to better fit individual subjects (Murray et al., 2018). In the following subsections, I briefly detail a few examples of theoretical models.

**Generative Models**

Generative models make inferences about unobservable neural states by sequentially taking in data, usually from neuroimaging, and updating the inner state of the model to better match the data. Neuroimaging models are based on properties of functional connectivity networks, which generalize small-scale neural features to systems-level responses (Stephan et al., 2015). fMRI, the predominant form of neuroimaging for these models, measures the Blood-Oxygen Level Dependent (BOLD) response. This is a correlate of neural activity, recorded at a millimeter scale, that abstracts layers of microcircuit interactions and single-neuron physiology. The most popular form of generative models, called dynamic caus-
al models, utilize a system of mathematical differential equations to represent high-level features in fMRI (Stephan et al., 2015). These can be used in psychiatry to examine how different dysfunctions in the neural state can lead to the observations from experimental recordings. In the future, psychiatrists could fit these models to patients to gain a deeper understanding of their specific biological dysfunction.

Reinforcement Learning

Reinforcement learning (RL) models have seen newfound success in representing psychiatric dysfunction. RL is a machine-learning approach that seeks to build adaptive algorithms that can maximize reward in a so-called environment. These are not explicitly taught the solution, as in supervised learning, but rather have to figure it out themselves. Neuroscientific RL is paralleled by artificial intelligence research, and contributions in one domain benefit the other. Computational algorithms such as the successor representation, an efficient form of reinforcement learning that has empirical ties to the function of the striatum in the brain (Dayan, 1993; Gershman, 2018), draw from both neuroscience and artificial intelligence (AI). Huys et al. (2015) used this algorithm to argue that depressive symptoms might draw from dysfunction in state-action evaluation, which is a particular step in the RL framework that requires an agent to choose a particular action given the state of the environment.

Through decision theory, an interdisciplinary field that seeks to study how decisions are made from an algorithmic and statistical perspective, psychiatric disorders can be viewed as occurring via self-reinforcing behavioral dysfunction: solving the wrong problem, such as in substance addiction, solving the right problem in the wrong manner, and solving the right problem correctly, but in the wrong environment, such as post-traumatic stress responses (Huys et al., 2015). These models interpret the effect of Selective Serotonin Reuptake Inhibitors (SSRIs) as normalizing the learning processes, which explains delayed antidepressant response via the corollary that further experience is necessary to relearn healthy behaviors. Some neuroscientists have sought to localize various psychiatric dysfunctions to the cortico-striato-thalamo-cortical loops, which RL connects to deficits in model-based learning or learning algorithms that build models of their environment to play more adaptively (Huys et al., 2016). Biological models can more precisely represent these circuits and have predictive power for disease progression or treatment effects.

Deep Learning

Deep learning has a unique connection to neuroscience as it is based on a reductive model of biological neural networks—neurons are viewed as simple computation devices that gain expressive power through their processing in a parallel and distributed manner—and can therefore model neural systems. Image recognition networks have been shown to replicate the visual cortex functional hierarchy (Richards et al., 2019). These have not yet been used to explicitly model psychiatric dysfunction, but initial forays should be expected in the near future. These systems are also effective in data-driven algorithms, and it is plausible that they will be used in each manner.

Hybrid Models

Hybrid models seek to utilize theory to develop features for data-driven models, which can improve predictive power by reducing noise in the data. Brodersen et al. (2011) modelled auditory cortex functional connectivity to identify aphasics—people who have lost the capacity of speech due to brain damage—with 98% accuracy. In this system, various generative models are fit to a dataset, followed by application of supervised algorithms on the features in the generative models (Brodersen et al., 2014; Stephan et al., 2015; Wicki et al., 2015). With a hybrid model, Frassee et al. (2020) classified depressive patients as chronic versus remissive with 79% accuracy, although the training set was quite small, at 85 subjects. Similar to deep learning models, more of these approaches should be expected in the near future. Using these models might be the most effective single way to bring computational psychiatry into the clinic, as it leverages the benefits of each type of approach.

Theoretical models lean more heavily on the research side of computational psychiatry, and therefore they have been treated with skepticism as to their potential efficacy in a clinical setting. However, a properly designed model provides a general framework that can be tailored to an individual patient, thus allowing for precision medicine, much like a laboratory test provides specific measurements that can be tied to a theoretical model of physiology to gain insight into that particular patient’s disorder.

Computational Approaches on Clinical Depression

In this section, I review a selection of studies on Major Depressive Disorder. These are not exhaustive but indicative of current trends.

Data-Driven Studies

Patel et al. (2016) summarize early computational psychiatry studies that use MRI data and focused on diagnosis. None of the patient samples exceeded 80 subjects, and methods tended to be linear, usually filtering voxels—individual pixels in an fMRI recording—with an unsupervised algorithm or functional knowledge. The following studies utilize more modern approaches.

Islam et al. (2018) extracted data from 7,145 Facebook comments to identify phrases that could predict depression, which they identified via a supervised model. They identified phrases with emotional, temporal, social, or perceptual qualities that significantly predicted onset of MDD. Chekroud et al. (2018) similarly used a dataset with 20,785 subjects from U.S. national surveys to determine whether a patient would seek treatment, doing so with 70.6% accuracy. It should be noted that this dataset was skewed female and white (72% and 77% respectively). Relevant predictors for initiation of treatment included dropping out of college or having no serious suicidal ideation. This model exemplifies how the computational methods discussed in this paper can not only prove relevant for clinical research, but also for a clinical setting. One would simply have to input phrases that a patient used into this system to determine whether or not they might be depressive.
Webb et al. (2018) identified a subset of 216 MDD patients that preferentially responded to sertraline (an SSRI) who were older, employed, more neurotic and depressive, and having stronger cognitive control than average. Bondar et al. (2020) utilized an unsupervised learning algorithm to identify two symptom clusters in adolescent depressives (n = 439), in which the first (social withdrawal, insomnia, fatigue, etc.) responded well to fluoxetine, an SSRI, and cognitive behavioral therapy, whereas the other (increased appetite, guilt, suicidal ideation, etc.) did not. Chekroud et al. (2016) utilized the open-source STAR*D database to identify variables to predict remission after citalopram treatment, finding significant contribution from employment status, psychomotor agitation, race, education, and more. Importantly, these are features that a psychiatrist might deem relevant.

Theoretical Studies

Generative models of depression are especially difficult to develop due to the heterogeneity of the disorder. Depression is associated with deficits in reward learning, especially in effort valuation (Huys & Roiser, 2018). Kumar et al. (2008) localized diminished prediction error signals in the ventral striatum, which correlated with a reduction in responsiveness to antidepressants. However, Rutledge et al. (2017) disputed this result in a larger sample, finding that moderately depressed patients maintained control-level reward prediction error signals. They utilized a computational model of happiness and found that severe MDD patients fit to this model differed only from controls by a static mood intercept, which the authors interpreted as a dysfunction in higher-order processing. These results agree with the psychological theory of baselines, which argues that a person’s happiness at any given time is related to their baseline quality of life (Young et al., 1996).

**HOW ARE THEORY-DRIVEN MODELS BETTER SUITED TO NEUROPSYCHIATRY?**

Theory-driven models emphasize underlying neural pathology. Biologically-driven theories attempt to explain features, such as the dysfunction of neurotransmitter systems, that can be further represented mathematically (Stephan et al., 2015). These models have strong predictive capabilities and can be further validated in translational animal studies, which allow for invasive experiments (Stephan et al., 2015). Additionally, they allow for the simulation of realistic data which could be used to predict disease progression (Frassle et al., 2017). Data-driven approaches do not have these capabilities, and these “black-box” models--so-called because their inner workings are not fully understood--can learn discriminatory representations if the data itself is biased, a historical problem in medicine. On the other hand, the interpretability and strict assumptions of theoretical models limit bias (Rutledge et al., 2019; Chandler et al., 2019).

Generative models that holistically represent dysfunctions as parameters or dynamics can be directly connected with individual patients, thus “treating the patient not the disease” (Stephan et al., 2015). Such approaches can additionally account for fine-grained changes which ripple to the global scale and to behavior. Because psychiatric disorders have been associated with systemic neuromodulator dysfunction, this is appealing. For example, the dopaminergic system is hypothesized to function as a prediction error signal, which is the learning signal in RL (Schultz et al., 1997). Similarly, serotonin has been theorized as a discounting parameter in a utility function, although it certainly has multiple functions (Huys et al., 2015). A discounting parameter is another feature in an RL algorithm that quantifies how much an agent “cares” about the future relative to the present, which is measured as an exponentially weighted sum of expected rewards. These theories provide explanations for the effects of therapeutics, while data-driven approaches cannot. Even better, generative models of adaptive plasticity can predict the mechanisms of treatment response based on the patient’s “neurotype” (Vinogradov, 2017).

Frassle et al. (2017) note that high dimensionality—the sheer number of features per data point—of neuroimaging introduces high levels of variance that is challenging even for ML. However, biologically interpretable features can separate classes of patients, on which traditional ML techniques can make predictions. An added benefit is that models can be compared to optimally explain a set of symptoms (Bennett et al., 2019).

**WHAT ARE SOME ISSUES WITH THEORY-DRIVEN MODELS?**

Precise mechanistic models are needed to sufficiently capture neural dynamics, which is a huge challenge. An incorrect or non-parasimonious model (one that is not sufficiently simplified while remaining precise) is likely to extract results from noise and therefore overfit (Deco & Kringelbach, 2014). The temporal-spatial restrictions of neuroimaging, as mentioned above, limit the ability of generative models to represent underlying activity. The complexity of whole brain models makes optimization increasingly intractable (not computable in a reasonable amount of time). Ultimately, an increase in computational power, sample size, and algorithmic heuristics will be required to train these systems to a functional level, just as the deep learning community found in the early 2010s (Chen & Lin, 2014). Theory-driven approaches have mainly focused on schizophrenia to date, but future trends will include other disorders (deFilippis et al., 2019). Like data-driven models, these systems have yet to move past the exploratory phase (Frassle et al., 2017).

Despite the fact that these methods are still in their infancy, it is likely that just as in other medicines, psychiatrists will soon implement artificial intelligence to aid their decision making. How might this look in practice? In the following section, I provide a novel four-step proposal that seeks to use the computational tools, developed by contemporary and future research, in a maximally-effective manner to treat mental health disorders.
In this section, I envision an integration of theory and data-driven models in clinical practice. The proposal contains four basic steps with a recurrence paradigm for long-term treatment when computational psychiatry approaches are sufficient for medicinal use. The following steps require a comprehensive set of algorithms to utilize all informative data. Note that this is a general plan and would require further personalization for precision medicine.

1. Immediate Treatment

Many psychiatric disorders require immediate treatment, such as suicidal ideation. Data-driven algorithms using information that is immediately collectable can provide initial treatment recommendations.

2. Biological data and theoretical models

Many psychiatric disorders require immediate treatment, such as suicidal ideation. Data-driven algorithms using information that is immediately collectable can provide initial treatment recommendations.

3. Longitudinal data collection

Over a specified time, the patient utilizes a smartphone application to record relevant data, such as sleep and movement, alongside surveys or virtual therapy sessions. These are factored into the history portion of the model in order to capture the dynamics of the patient’s disorder.

4. Informed, holistic treatment

As treatment continues, the historical information is integrated into a single, cumulative model, and a clinician designs a more general treatment plan. Efficacy of the treatment can be revised by repeating these steps. This precision medicine approach accounts for many of the elements of experience desired by vocal opponents to personalized psychiatry (Stiefel et al., 2019). No single step will be sufficient, as indicated by preliminary research.

**DISCUSSION**

The development of computational psychiatry is still exploratory; clinical efficacy is far off. ML is a necessary tool but not a silver bullet; applying these models unintelligently will not suddenly solve decades-old problems. Simon (2019) makes an excellent analogy, emphasizing that despite the hype of ML, we cannot become like a child with a hammer, pounding anything that looks like a nail. Contrarians argue that computational models cannot be as effective as a clinician, because they do not have an understanding of subjective experience.

Translational computational tools need to derive from basic science. Neuroscience and psychiatry will benefit greatly from scientists who have rigorously studied theory and methodology (Mai-an Vu et al., 2018; Cearns et al., 2019). Theoretical approaches have yet to begin answering the questions desired of computational psychiatry due to extensive methodological development. Asking the right questions is crucial, and we must take the time to do so. Are our computational tools powerful enough for these approaches? The answer is yes, but the more pertinent question is whether we have the right type of data. Computational psychiatry researchers are hence cautiously optimistic about the clinical viability of ML methods (Chekroud & Koutsouleris, 2017).

**CONCLUSION**

Perhaps it is too early to determine whether theoretical or data-driven approaches will be more efficacious for the future of computational psychiatry and clinical practice. In all likelihood, both methods will be necessary. The majority of research in this field requires a stronger theoretical foundation that will currently hinder the development of clinical tools, but it is still important to consider how clinical research can translate. This will be useful to psychiatry in general, as biologically-backed theories can help improve the definitions and treatments of disorders in the DSM. Psychiatrists will of course never be phased out, but machine learning algorithms can pick up trends that even the expert eye cannot capture in vast amounts of data. Furthermore, efforts to create testable theoretical models must keep pace with their counterpart as these studies will be more informative in the long run. Scientists, hospitals, and therapy developers will need to communicate intensively to steer psychiatry into a new era. With time, psychiatry will soon join other disciplines in the era of precision medicine.

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Brodersen, K. H., Deserno, L., Schlagenhauf, F., Lin, Z., Penny, W.


In the Seo Lab at the Yale School of Medicine, senior Mitchell Ostrow found his passion at the intersection of computational modeling, machine learning, and neuroscience—studying deep neural networks as models of the brain. To Ostrow, studying these models is especially exciting because through artificial intelligence, his findings can directly impact the world on top of moving science forward. For example, they could potentially be used to synthesize drugs or devise new treatments immediately. Ultimately, Ostrow’s commitment to pursuing what intrigued him the most led him to this research area.

“From doing so much exploration, I was able to really narrow down my interests and find something that I absolutely love and can definitely see myself doing for the rest of my life,” Ostrow said. Right now, that means pursuing a PhD in Computational Neuroscience to study the intersection of AI and neuroscience.

Outside of research, Ostrow enjoys exercise and spending time in nature. Additionally, he is heavily invested in music, formerly playing trombone in the Yale Symphony Orchestra, a trombone choir called Scale and Bones (which he founded), and a brass choir called Coup de Brass. Before college, his identity was predominantly as a trombone player and as a musician. Although he still sees himself in this way, his identity has transformed into that of a researcher.

Surprisingly, he has found commonalities among these two worlds. Initially, most of your time is spent developing technical skills—such as playing scales for trombone and learning how to analyze papers in research. As you progress, however, you develop your own style or you create your own experiments, and creativity flourishes. Moreover, music and research are both personally rewarding as well as community-oriented.

“Science is for society to gain knowledge and music is for other people to enjoy,” Ostrow said. “To me, it’s more about appreciating the music or appreciating creating knowledge for myself, and it’s an added benefit that other people enjoy it.”

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ABSTRACT

While prior studies have identified recurring genetic patterns, gaps of knowledge still remain in existing aging mechanisms; where they originate, and how they offer insight to environmental disruptions that dictate health over time. Given the inescapability of age-related deterioration and pathology, stitching together current literature may help demystify the biological process common to all living mammals. The physiological disruption of aged tissue reflects a cellular dependence on environmental cues and historical wear. Retaining the capacity to differentiate into any cell type, a stem cell best parallels a call-and-response relationship between organ and cell. As the longest living proliferative cell in multicellular organisms, stem cells respond to environmental cues through genomic or proteomic shifts. Aging tends to disrupt this capability, as stem cells lose functionality over time. This review will focus on the mechanisms associated with stem cell depletion and skin tissue degeneration. By concentrating on genetic pathways common in studies comparing caloric restriction models in young and old species, this review will highlight commonalities that generate age-related stem cell depletion and tissue degeneration.

CALORIC RESTRICTION (CR) AS AN ANTI-AGING INFLUENCER

In 2019, the 65+ year old age group represented 16.5 percent of the American population. By 2050, this number is expected to reach 22 percent, roughly one quarter of the entire nation. While improved livelihood is a signifier of a developed nation’s technological, scientific, and medical advancements, the degenerative repercussions of aging are hardly understood. The onset of chronic illness can burden hefty economic costs from nursing homes, medical treatment, and health insurance. In addition to monetary expenses, age is correlated with high risk of developing chronic disease. Unfortunately, aging is not a manifestation of one particular molecular disturbance, but results from a series of microscopic alterations, that culminate in external and internal deterioration. In other words, these changes are not merely triggered by an on switch in the body, but a history of environmental and innate interactions.

Witnessing phenotypic indications like decelerated mobility, stark facial changes, and body mass alterations, scientists have been able to name aging without necessarily understanding it. In a review of modern aging research, Professor Kayvan Zainabadi stresses that all living beings have a common denominator named death; and it is the rate of reaching that point which motivates modern aging characterization of aging itself, but for the model in which it recreated the aged phenotype. Rather than relying on a natural progression over time, researchers elicited the aged phenotype through metabolic manipulation. By manually altering the cellular environment of the organism, caloric restriction (CR) proved a successful, non-invasive model to delay ageing and subdue pathological disease (López-Lluch & Navas, 2016). By reducing energy intake without provoking malnutrition, the aged phenotype was reversed and pathological deterioration was avoided. Not long after this discovery, the National Institute of Aging began extending lifespan 3-fold with CR alone, and performed targeted drug treatment on mice, flies, worms, and yeast, to effectively stretch lifespan up by 10-fold in yeast (Fontana, Partridge, & Longo, 2010). Hipkiss clarifies this phenomenon in the “Hormesis hypothesis of CR,” which explains how the mild survival pressure triggered by fuel depletion, causes an upsurge in organ and cell protection amidst environmental adversity (Hipkiss, 2007). Essentially, ensuring pathways of CR activate cell longevity and protection, producing an antiaging phenotype reflective of younger organisms. The main pathway influenced by dietary intervention is the insulin/insulin-like growth fac-
tor (IIS) pathway (Santos, Leitão-Correia, Sousa, & Leão, 2016). Many of the IIS pathway constituents have been dissected and analyzed in overlapping studies of CR-induced and aged organisms. Within this overlap, current studies have defined key molecular players responsible for age-related deterioration. Due to the vast stretch of age-related pathology, this review will narrow the scope of aging to a system depicting both of these manifestations.

**DETERIORATION OF SKIN EPITHELIUM IN AGING**

At the interface of environment and internal anatomy, skin is a unique organ that presents both biological and external repercussions of health detriment. The adult skin epithelium is comprised of a pilosebaceous unit containing a hair follicle (HF) and sebaceous gland. With the need to efficiently respond to environmental cues and damage, homeostatic regulation is crucial in maintaining the integrity of the skin structure and health. In fact, injury to this protective layer increases susceptibility to diseases caused by environmental irritants, and benign or more threatening pathological manifestations like pruritus, carcinomas, or melanomas (Farage, Miller, Elsner, & Maibach, 2013). From an external perspective, most histological studies have reported signs of atrophy, epidermal thinning, and abnormal fiber reconstruction (Bhattacharyya T.K., 2010). Studies specific to mouse-models verify a consistent thinning of the epidermal layer, with shortened and sparse hair follicles in older mice (Bhattacharyya T.K., 2010). Additional studies report atrophied sebaceous glands and decreased dermal cellularity, further suggesting the role of aging in homeostatic cell proliferation and death (Giangreco A, 2008).

**CHARACTERISTICS OF A STEM CELL**

From a common tissue origin, stem cells self-renew and differentiate into multiple lineages (Blanpain & Fuchs, 2006). The skin possesses different subpopulations of stem cells; each play a role in sustaining organs by differentiating into specialized cell types. Layers within the epidermis encapsulate hair follicles (HFs), sebaceous gland, mammary glands, and sweat (Ge et al., 2020). The hair follicle stem cell (HFSC) sits in a stem cell niche called the bulge—its master regulator. Harvesting control over stem cell homeostasis through extracellular communication, the niche contains cells in contact with stem cells and other soluble factors (Gianluigi Mazzoccoli, Tevy, Borghesan, Vergini, & Vinciguerra, 2014). The surrounding dermal papilla, lymphatic capillaries, adipose tissue, and dermal fibroblasts, signal the HFSC to rest (quiescence) or regenerate (differentiation). Rather than self-renewing the HF pool, damage to HFSC DNA causes HFSCs to escape the niche and differentiate to keratinocytes that eventually flake off the skin surface (Matsumura et al., 2016). This mechanism is likely responsible for the hair-thinning phenotype common in aging; elucidating a relationship between hair and skin, activated from damaged DNA. Studies utilizing CR to reverse aged phenotypes discover similar HFSC pool remodeling, in which an increase in quantity and regrowth rate present a decrease in stem cell quantity, with much shorter and sparser fur coats as a result of HF miniaturization (Forni et al., 2017).

This research, alongside prior studies on stem cell regulation and homeostasis, define the roles of nutrient-sensing pathways and metabolic regulation that define the “stem-ness” of stem cells. While the mechanisms of nutrient sensing may differ across varying stem cell species, the quiescence and differentiation switches inherent in both pluripotent and multipotent stem cells, appear to be affected by metabolic cycles such as glycolysis and the IIS pathway (Ochocki & Simon, 2013). Through diet manipulation from the CR condition, there is significant evidence to support the role of nutrient sensing in prompting cues within the stem cell niche, and triggering downstream feedback loops.

**HOMEOSTATIC ISSUES IN AGING**

By reducing major energy pathways, CR promotes stem cell self-renewal and regeneration, while decreasing differentiation. Stem cell quiescence is necessary for stem cells to pause, and avoid a build-up of epigenetic alterations that compromise function (Ermolaeva, Neri, Ori, & Rudolph, 2018). Exhaustion of stem cell activity can spike an increase of SC proliferation, also initiating cell damage that impairs function and accumulates misfolded proteins (Ermolaeva et al., 2018). Many of the factors that determine this activity are transpired by communication through the stem cell niche. The pathological alterations made to them can be categorized as extrinsic (stem cell niche alterations, systemic factors) or intrinsic (epigenetic changes, DNA damage) (Maharajan, Vijayakumar, Jang, & Cho, 2020).

This explains how the “starvation” mode of CR condition activates a series of proteins involved in autophagy, stem cell self-renewal, and antioxidant activity. Subsequent hormonal shifts in insulin, IGF-1, and leptin, all interplay to inhibit mTOR signaling pathways and downstream effects (Gianluigi Mazzoccoli et al., 2014). In comparison to young and old mice, mTORC1 was expressed more abundantly in old mice overall (Chen, Liu, Liu, & Zheng, 2009). Within the scope of skin, inhibited mTORC1 was found to decrease differentiated epidermal stem cell senescence; which may have been due to a decrease in cytokines circulating around the stem cell niche (Chung et al., 2019). Due to a resulting nutrient abundance, insulin and growth factors increase, autophagy is inhibited, and protein synthesis is encouraged in ad libitum treatments. Additional studies utilizing mTOR have recreated these CR mimetic outcomes, prompting mTOR as a pivotal gene in stem cell communication.

Achieving longevity while compensating fuel loss is essential in reproducing the anti-aging effects of CR. In response to low food intake, autophagy pathways recycle unwanted organelles in the body, and refuel the cell for upcoming biosynthetic reactions (G. Mazzoccoli, Tevy, Borghesan, Delle Vergini, & Vinciguerra, 2014). When exogenous substrates are absent, lysosomes degrade unwanted cargo, and autophagy salvages the debris to produce a source of amino acids for glucogenesis. CR induces autophagy upon this same “starvation” mechanism. AMP-activated protein kinase (AMPK) is one of the factors that senses nutritional changes during CR, inhibits expression of mTORC1, and switches on catabolic pathways to produce ATP (Cantó et al., 2009). This amplified metabolic activity
increases NAD+ in the cell environment, inadvertently triggering SIRT1—a factor responsible for deacetylating FOXO1 (Pan & Finkel, 2017). In order to better understand this responsive mechanism transpired by the IIS pathway, the individual responsibilities for each gene should be closely examined; alongside comparative studies that elicit similar responses amongst young and CR-treated organisms.

**FOXO TRANSCRIPTION FACTORS**

The FOXO family of transcription factors have demonstrated pro-longevity effects in prior ageing studies unrelated to stem cell function. They often serve as a major substrate of protein kinase Akt in the presence of growth factors or insulin (Greer & Brunet, 2005). When found in the nucleus, they upregulate a series of target genes responsible for stress resistance, cell cycle arrest, or apoptosis (Greer & Brunet, 2005). However, they only remain in the nucleus in the absence of growth factors and insulin (Greer & Brunet, 2005).

Subcellular localization of FOXO from environmental cues such as growth factors and insulin, determines whether or not FOXO interacts with cell regulatory gene expression (Hosaka et al., 2004). In the presence of factors such as insulin or growth factor (GF), FOXO proteins localize to the cytoplasm (Hosaka et al., 2004). This sequestration promotes expression of cell proliferation and stress sensitivity. The resulting metabolic shift from glucose to lipid oxidation suppresses inflammation and induces mitochondrial biogenesis (van Heemst, 2010). With a heavy influence of FOXO activation upon cell-cycle and replication, these transcription factors are often involved in cancer studies focused on tumor suppression and organismal longevity (van Heemst, 2010).

In addition to its involvement in epidermal stem cells (epSCs), FOXO proteins also prep Hematopoietic stem cells (HSCs) for autophagy during CR (Hosaka et al., 2004). FOXO upregulation in mice HSCs induce vigorous autophagy under the CR condition, and markedly downregulate pro-autophagic targets upon deletion (Warr et al., 2013). Not only does this upregulation in HSCs suggest a common function of FOXO across various stem cells, but CR’s influence on HSCs can also play a role in shifting the niche environment of epSCs, through modulation of reactive oxygen species (Ludin et al., 2014). Additional to CR studies, many studies have explored differences in these nutritional profiles of niches between young and old mice. The presence of 2-NBD glucose was the single identified difference between young and old mice with different autophagy fluxes (Warr et al., 2013). Preparing an equipped responsiveness in SCs, FOXO proteins represent a necessary and conserved effort to alleviate strains of an energy crisis (Warr et al., 2013). Both the increase of antioxidant expression, and decrease of superoxide production after glucose reduction, can be attributed to FOXO1 nuclear translocation; which affects DNA building and transcriptional activity (Hosaka et al., 2004). Through a consistent role in determining stem cell function, FOXO proteins offer an intriguing glimpse of how nutritional factors from diet influence stem cell homeostasis. Obviously, other genetic players are involved in this regulation—such as sirtuin (SIR) recently capturing more attention through its prominence in modern aging studies.

**SIRTUIN NAD-DEPENDENT PROTEINS**

Downstream to the IGF-1 signaling pathways, SIRT1 is activated under CR conditions in which growth factors and insulin are sparse (Cohen et al., 2004). Through ROS elimination, sirtuins encourage stem cell self-renewal, function and regeneration (Matsui et al., 2012). One of its main targets is the FOXO transcription factor, which as previously discussed, plays a major role in SC autophagy. Between wild type and SIRT1 knockout samples from mice, SIRT1 knockouts present debilitated self-renewing capacity, suggesting SIRT1 pivotal in maintaining a stem cell’s “stemness” (Matsui et al., 2012).

Sirtuins have been described as nicotinamide adenine dinucleotide (NAD)-dependent protein type III histone deacetylases (HDACs) (Schemies, Uciechowska, Sippl, & Jung, 2010). This class of proteins deacetylates histones on DNA, allowing room to bind DNA around histones of nucleosomes (Schemies, 2010). This is a clever epigenetic mechanism, which allows sirtuins to influence expression of genes involved in DNA damage, stress response, and lipid metabolism (Ermolaeva, M. & Rudolph, K. L., 2018). As implied by the name, this class of protein also requires an NAD+ substrate; and the presence of such is highly determined by the nutritional status of the cell. Thus, as the CR condition triggers a shift in the nutritional environment of the SC, the sirtuin protein—and its downstream effects—are activated as a result (López-Lluch, G., & Navas, P., 2016). Sirtuins also silence recombination between recombinant DNA (rDNA) repeats, while mutation of Sir2 results in a marked accumulation of extrachromosomal rDNA circles (ERCs) that induce nuclear fragmentation, cessation of cell division, and cellular senescence (Sinclair & Guarente, 1997).
CONNECTING GENETIC MECHANISMS IN THE LARGER PICTURE

We’ve broadly discussed how INS/IGF/GH signaling dependent metabolic pathways influence aged phenotypes in stem cells. In regards to its homeostatic functions, high caloric intake activates stem cell proliferation and differentiation via mTORC1 signaling. This cell-cell communication begins at the niche, where niche cells sense and govern SC activity through signaling molecules (von Frisch & Roeder, 2020). While mere proliferation appears harmless in the grand scheme of stem cell homeostasis, consistent differentiation increases risks of developing misfolded proteins and damaged cells (Gianluigi Mazzoccoli, Tevy, Borghesan, Vergini, & Vinciguerra, 2014). Over time, these stem cells demonstrate decreased self-renewal, regeneration, and function—in other words, the exact phenotype exemplified in aged individuals (Oh, Lee, & Wagers, 2014). The metabolic remodeling of the IIS pathway—triggered by CR—perfectly exemplifies how FOXO, SIRT1, and AMPK might fold into one another.

The insulin signaling network (IIS) triggers mTOR activation, through a known nutrient-sensing pathway that interacts with factors sought by caloric consumption (Tang et al., 2019). mTORC1 is responsive to both extracellular and intracellular stimuli like growth factors, hormones, amino acids, and energetic stress. It is negatively regulated by AMPK activators that sense nutritional status of the stem cell niche and inhibit mTORC1 complexes in response to nutrient depletion (Papadopoli et al., 2019). Akt is an upstream activator of mTORC1 and is similarly inhibited when AMPK suppresses mTORC1 (Greer, Banko, & Brunet, 2009). However, through feedback inhibition, AMPK activates FOXO1 (Greer, Banko, & Brunet, 2009). Additional activation of FOXO1 results from the deacetylation activity of SIRT1, a downstream neighbor to IGF-1 activated by the absence of insulin (Kobayashi et al., 2005). From prior analysis, each of these genes appear to influence stem cell homeostasis through downstream activation or inhibition of target genes involved in SC differentiation and quiescence. Thus, the IIS pathway specifically represents a conserved effort to maintain metabolic and energy homeostasis (L. Wang, Karpac, & Jasper, 2014).

While this is simply one pathway triggered via insulin activation, there are numerous ways for genetic activity to be determined by aging in itself. As time elapses, stem cells sit in aged tissue, exposed to both endogenous and exogenous sources that can damage DNA (Oh et al., 2014). While mechanisms of DNA damage in aged stem cells are still under study, genotoxic lesions from an increased rate of damage, or inefficiency in DNA repair pathways, can both accelerate an aged phenotype (Oh et al., 2014). Between young and old mice, DNA damage analysis in HSCs present significant strand breakage in older individuals. (Beerman, Seita, Inlay, Weissman, & Rossi, 2014). Rather than a measurable influence on cell death or proliferation, irregular stem cell quiescence reaps greater damage to DNA repair mechanisms (Beerman et al., 2014). While DNA damage is common in other pathological manifestations, the factors that procure this damage in epidermal SCs are worth investigating.

Proliferation of epSCs follow a rhythmic regulation of activation and quiescent pathways. In order to circumvent genotoxic lesions caused by maximum oxidative phosphorylation in the day, mice epSCs replicate their DNA in the night (Solanas et al., 2017). While this cycle may be expected to diverge over time, aged epSCs remain just as rhythmic as their younger counterparts (Solanas et al., 2017). That being said, their epSCs are still forced to rewire and adapt to environmental challenges that would maximize energy efficiency (Solanas et al., 2017). Initially, it was presumed that genetic alterations were responsible for this inefficient activation (Solanas et al., 2017). However, upon knocking out genetic controllers identified with the circadian rhythm, the aged phenotype was not recreated; suggesting some other type of genetic remodeling to have produced these effects in young and old mice (Solanas et al., 2017). While this study did not pursue epigenetic analysis further, the inability to reproduce this same rewiring with knockouts, may suggest epigenetic alterations as responsible for inefficient energy usage over time.

Epigenetic reprogramming in SCs has prompted interest for its influence on homeostatic regulation. The SC genome can be altered easily by environmental stimuli, which determines expression of epigenetic regulators. Relaying inflammatory cues such as cytokines, growth factors, or adhesions molecules, the stem cell niche may have a strong influence on compounding aged phenotypes. If certain cues regulate gene expression, new shifts in SC activity can inadvertently influence tissue health and homeostasis. For example, DNA methylation has been found to suppress genes related to cell cycle exit and keratinocyte differentiation from epSCs; which can lead to possible atrophying of the epidermal surface (Mulder et al., 2012).

CLONAL EXPANSION

Amidst challenges to maintain SC homeostasis, epigenetic alterations in certain daughter cells can ripple subsequent mutations in SC progeny. Expansion across multiple progenies create a clone dominance that outweighs the normal SC gene profile and impairs tissue homeostasis. This process is defined as epigenetic drift and clonal expansion, and is characterized by age-dependent changes in the CpG methylome, heterochromatinization of precise areas of the genome, and reinforcement of open chromatin regions (Kirschner et al., 2017). Impairments in key epigenetic modifiers through this epigenetic drift have been found to mutate HSCs, and incite damage in cell differentiation, tissue dysfunction, and cancers (Kirschner et al., 2017).

Transition from stem cell to transient amplifying cells defines the clonal expansion process. Clonal expansion of epSCs is highly regulated by tumor suppressors such as p16INK4a. By inhibiting the G1/S-phase transition in cell cycle, P16INK4a governs SC self-renewal in skin tissue (Orioli & Dellamba, 2018). However, as an aberrant chromatin sensor, p16INK4a induces tumor suppressive cell senescence pathways, which can exhaust epithelial stem cells over time (Iglesias-Bartolome, Callejas-Valera, & Gutkind, 2013). Thus, maintenance of skin SC population homeostasis is highly dependent on p16INK4a repression, as it directly coordinates a
genetic balance between keratinocyte renewal and differentiation (D’Arcangelo, Tinaburri, & Dellambra, 2017). Multiple epigenetic alterations can target the repression of P16INK4a, including the usage of histone deacetylases (HDAC) (D’Arcangelo et al., 2017). SIRT1 actually serves as an HDAC under CR. The scarcity of free-floating glucose under CR, actually causes SIRT1 to suppress P16INK4a through direct deacetylation, just as those that balance keratinocyte renewal and differentiation (Li & Tollefsbol, 2011).

**STEPS FORWARD IN PHARMACEUTICAL APPROACHES AND FUTURE STUDY**

Regarding stem cell longevity, anti-aging therapeutics should strike a balance between SC senescence and quiescence. We’ve reviewed how the IIS pathway altered by CR can influence either fate, by initiating specific nutritional shifts and epigenetic alterations. That being said, genetic control of homeostasis must be approached with caution. A pathological imbalance can tip SCs to extreme self-renewal or differentiation (Oh et al., 2014).

In order to gain control of this process, countless studies have suggested bloodborne factors as an indirect focus for stem cell engineering. GDF11 supplementation was found to reverse hypertrophy in cardiac muscle through activation of TGF-beta pathways in human-induced pluripotent stem cell-derived cardiomyocytes (Loffredo et al., 2013). Utilizing some of the key players addressed in CR studies, direct inhibition of mTORC1 through dTsc1 suppression in c. elegans and drosophila, were found to extend lifespan as well (Jia, Chen, & Riddle, 2004) (Kapahi et al., 2004). Pharmaceutical inhibition of mTOR by rapamycin alone, redeemed self-renewal and hematopoietic potential in mice (Chen et al., 2009).

Metformin, an existing Diabetes treatment that enhances insulin sensitivity, is another drug that targets downstream players of the IIS pathway. Since AMP-activated protein kinase activity is a direct target of this drug, the effects on physical performance, insulin sensitivity, and reduced cholesterol levels, all mimic those of the CR condition in mice (Martin-Montalvo et al., 2013). Chronic exposure to metformin in mice lengthened lifespan and produced anti-aging properties (Martin-Montalvo et al., 2013). However, the dosage associated with mice was much higher than that typically used in diabetes treatment (Martin-Montalvo et al., 2013). Because the pharmacokinetic disruptions from chronic exposure levels are not fully understood, more studies are necessary to determine the efficacy and safety in humans.

Alongside systemic regulators, direct targeting of senescent cells and their products in aged tissue, is another therapeutic possibility. One study designed a drug containing a transgene that eliminated P16INK4a-positive senescent cells (Baker et al., 2011). The adipose tissue of mice that received life-long treatment, demonstrated delayed aging phenotypes typical in P16INK4a active cell types (Baker et al., 2011). Furthermore, ablation of P16INK4a in aged mice reverted pathological deterioration in skin tissue (Baker et al., 2011).

**CONCLUSION**

This review focused on age-related pathologies found in the skin, caused by malfunctioning stem cell homeostasis. We considered CR-related studies to better understand how the IIS pathway relates to anti-aging therapeutics. Through the genetic mechanisms of mTORC1, FOXO1, SIRT1, and AMPK, we initially clarified how environmental factors influence nutritional status in the stem cell niche, and trigger genetic cascades that encourage adaptive response pathways under starvation conditions. The epigenetic alterations embedded in these response pathways, alongside their influence on stem cell function and skin homeostasis, were further investigated in studies both on aged and CR-treated organisms. We concluded with pharmaceutical translations, and how future directions inspired by CR genetic pathways could lead to advancements in therapeutics that address age-related pathologies.

While further studies on CR and its supporting mechanistic routes are necessary to better define “aging,” a strong understanding of pathophysiological features can help address disease risks more effectively. Additionally, the therapeutic advancements inspired by this research withholds possibilities to better define health status, as the definition of good health, is not aptly captured by surface-level metrics. Likewise, the pathway to good health is not paved equally for everyone. While this remains an untapped field, perhaps by
learning from the environmental-biological synergy elucidated in this paper; we can finally allow scientific inquiry to address systemic inequalities, and regard external factors as a source of health detriment.

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After a long day at the Horsley lab investigating the role of caloric restriction on mice, Valerie Navarrete ‘21 turns to her creative outlet, art, to relax and de-stress. As a double-major student in Molecular, Cellular, and Developmental Biology and art, she ultimately hopes to explore science and medicine from an artistic lens. At the Horsley lab, Navarrete works with her mentor, Valerie Horsley, on the effect of caloric restriction on mice. In her experiments, they discovered phenotypic differences between two groups of mice, where the one with caloric restriction visibly and internally looked younger than the group of mice with unrestricted feeding. To further investigate the mechanism and aging process, she analyzed the role of nutrition and environment on stem cell populations at the cellular level and epigenetic level. Navarrete first became acquainted with Professor Horsley through her class, Biology 102: The Cell. “I always thought she was so cool and cared so much about her students,” she said.

Later on, she became interested in stem cell research after reading a newsletter spotlighting Professor Horsley’s research on stem cells her first year. When she started emailing professors for a lab position in her junior year, Navarrete remembered Horsley’s research and decided to reach out. She credits Horsley and her mentors in the lab for solidifying her interest in STEM and biology. “I love her lab. I think her lab, my mentors and all the women that are a part of that collective is a big reason why I feel confident in biology now and why I love science so much. I want to pursue an MD/Ph.D. down the road, but before that, I wasn’t really big on research because of the whole stereotype and stigmas behind it,” Navarrete said. Outside of the Horsley lab, Navarrete illustrates for the Yale Daily News and actively participates in Yale’s Slavic chorus. She also paints and sketches in her free time. “I’m using art to understand myself, my history, my identity. And once I do that I could really get into the meat doing it for other people and finding how to apply it in the scientific realm,” Navarrete said.

After graduation she is considering attending a program with Rhode Island School of Design (RISD), in order to gain some artistic and clinical experience before applying to MD/Ph.D programs in the future.

For the full-length profile, visit yalesymposia.com
ABSTRACTS

Out of over 150 submissions, 30% were selected for publication in our spring issue. As we received many more excellent articles than we can print, we will continue to publish them online over the next several months. As a preview, abstracts of these articles are included below. We will be publishing the full articles on our website, yurj.yale.edu. To receive notifications as we release them, like and follow our Facebook page: facebook.com/theyurj.

Humanities

A Case for African American Reparations: The Inheritance of Racist Hierarchies and Moral Harm
Ko Lyn Cheang

In this paper, I will argue that living white Americans with no individual ethical responsibility in original wrongdoings such as slavery, segregation and mass incarceration against African Americans in the United States have an obligation to repair the ongoing, present-day reproductions of past injuries. Using the Lockean inheritance argument for Black reparations laid out by Bernard R. Boxill as a starting point, I will show how a narrow conception of inheritance as property-based and merely legal is insufficient to justify reparations for non-property-based harms such as dignity loss or bodily violations. Drawing upon James’ Baldwin’s notion of history to explain the collective and structural nature of non-material harms caused by racial injustice, I’ll show how racist hierarchies of desert and value are historically transmitted and create obligations for present-day persons to repair them.

Exhibiting Text as a Spatial Object in the Beijing Lu Xun Museum
Formosa Deppman

Lu Xun preserves a certain complexity and reflectivity in his writings that avoid overly simplistic interpretations. But what happens when a text is taken out of its literary context and exhibited as visual art? By examining the two cases of the Beijing Lu Xun Museum and the Former Residence of Lu Xun, we observe different inversions of meanings that allow for new forms of heterogeneity to be played out in a spatial realm. The text-focused curative style of the Beijing Lu Xun Museum decontextualizes Lu Xun’s quotes to create more generalizable meanings for viewers. The Former Residence of Lu Xun relies on the immersive quality of space—and lack of text—to allow visitors to re-imagine Lu Xun’s daily life, and see him not as a grandeiose literary figure, but as a regular person in material reality. What results from the combined comparison of these two exhibits is a new physical portrayal of Lu Xun that integrates its heterogenous components into a unified exhibition.

The Stories Behind the Stories: Mediation of Narratives in David’s Story
Naima Kalra Gupta

The Truth and Reconciliation Committee was set up in the aftermath of apartheid to bring to the surface human rights abuses that took place in the apartheid era, through witness testimony and recounting of trauma. The TRC undoubtedly brought to the forefront the challenges of narrating and the reasons for remembering a contested and traumatic past. It is impossible to read David’s Story, which shifts temporally between Griqua efforts for self-determination and the South African liberation movement and foregrounds the act of telling, without taking into account the ambitious project of the TRC. This paper examines how history is made and articulated in David’s Story. Wicomb’s novel is a larger exploration in how stories are translated, transcribed and retold through multiple narrators and mediators, prompting readers to question the ownership and authority of written and oral histories.

Spectacular Interiority in Post-Apartheid South African Literature
Jaehyun Kim

Near the fall of apartheid, South Africa underwent a literary transformation. No longer bound by racialized dichotomies, South African authors rejected extreme narratives (called spectacular exteriority) in favor of nuanced, analytical, and personal ones. This paper argues that the extreme, spectacular representations remain an essential part of two works of post-apartheid literature, Thirteen Cents by K. Sello Duiker and The Folly by Ivan Vladislavić—however, with a twist. Instead of crafting extreme descriptions and events of society, the authors are more concerned with crafting extreme descriptions and thoughts of the characters’ minds. Within these novels, characters experience graphic, subjective, and hallucinatory visions which call to attention the social struggles that remain on a less visible, more personal level after apartheid’s abolition.

The War on Fire: Construction of Enemies and the U.S. Forest Service
Isabel Kirsch

I analyze the parallel constructions of the institution of the United States Forest Service and the idea of fire as a public enemy in the first half of the twentieth century. From where did this fire-as-enemy construction emerge, and what purpose did it serve? I draw extensively from Yale collections for my research, including glass slides of early-1900s forest fire prevention posters, a pamphlet of eerie children’s songs from 1928 with violent language about punishing those who start forest fires, and a Yale School of Forestry and Environmental Studies student’s 1934 thesis. I argue that equating forest fire with a public enemy has logical roots in the connections between fighting fire and fighting war, especially following the 1910 Great Fires. This construction both came from and bolstered the United States Forest Service (USFS) as it transformed from a fledgling government agency to a department marshaling the resources of a sizable army. The power of
propaganda entrenched this construction in the public conscience by connecting forest fires and waste of natural resources, a particularly impactful link during the economic crisis of the 1930s. The fire-as-enemy construction justified a policy of total fire suppression by equating fire suppression with waste prevention, casting the ultimate enemy not as fire, but as the waste of resources.

Costuming Characters in Early Medieval Irish Literature Lydia Lee

Clothing in early medieval Irish literature can often serve as a representation of a character’s wealth and status. However, this paper asserts that the storytellers of these texts costume characters in order to reflect more nuanced layers of their identity. By examining the ways in which clothing is articulated in Irish tales from the Mythological Cycle and the Ulster Cycle, as well as the legal text “Cáin Íarraith,” this paper argues that storytellers use garments to indicate a character’s geographical roots and occupation, reinforce customs and strengthen social bonds, comment on gender roles of aristocratic women, and serve as a characterization device. By analyzing how attire is portrayed in these texts, one can glean how this society may have used clothing to define identity beyond socioeconomic class.

Social Science

Optimal Information Design in Two-Sided Trade Pradhi Aggarwal, Dirk Bergemann

In a two-sided market with a broker, the broker can influence the buyer’s and seller’s optimal trading behaviour through strategic information design. We study the impact of information about waiting times on riders and drivers in a rideshare market. We consider three information regimes: the first in which no information about time is revealed, the second in which true waiting times are communicated, and finally an intermediate regime in which agents are only told whether their waiting time falls within a high or low category. We compute welfare-maximizing and revenue maximizing mechanisms for each setting and find that by concealing information, the broker can incentivize agents to accept less favorable trades. On the other hand, more information restricts trade to sufficiently favourable bargains, yielding higher expected welfare and expected revenue.

The Run on Repo and Bank Stock Returns Madison Marie Battaglia

The run on the sale and repurchase market (“run on repo”) was at the nexus of the Financial Crisis of 2007-2009. Up until now, the economics literature has not studied the effect of sale and repurchase agreement (“repo”) haircuts on bank stock returns using an empirical economic approach. I utilize private repo haircut data from 2007Q1-2009Q1 supplemented with bank stock returns, total reserve balances, and market rate of returns and risk-free rate of returns data to trace the path of crisis from repurchase agree-

Returning to the Gender Gap in College Major: How Much Can Pre-College Skills Explain? Nathalie Beauchamps

The gender wage gap in the United States is a well-known phenomenon and researchers across many disciplines have tried to pinpoint its cause. One popular explanation is the gender gap in college major choice; however, it is still unknown why women tend to major in so-called soft sciences and men in hard sciences. This paper builds upon Speer (2017)’s work studying the gender gap in major choice as explained by test scores. Rather than utilizing OLS regressions, I employ a Kitagawa-Oaxaca-Blinder decomposition method, which also shows how unspecified discrimination works for or against women (or men) in how much their test scores contribute to their major choice. Utilizing the ASVAB pre-college test scores, I find that there is an overall larger unexplained gap when using the male counterfactual in the Kitagawa-Oaxaca-Blinder decomposition versus the female counterfactual regarding the explanatory power of test scores for various majors. This suggests the unexplained difference in how test scores predict college major stems from unspecified discrimination in favor of men.

Recognising the Pitfalls of the Past: Community Health Workers in the time of COVID-19 Sam Brakarsh

Since their formal inception in the 1960s, Community Health Worker (CHW) programs have been revered as a panacea by some and critiqued as a delusion by others (R. N. Labonte et al., 2017; R. Labonte & Saunders, 2015). CHW programs can yield up to a 10:1 return on investment, mobilising communities to take preventative actions to tackle some of the most overwhelming diseases of our time (Earth Institute at Columbia University, 2013; WHO, 2015). However, when carried out without appropriate support or integration into broader health systems, CHW programs cease to be comprehensive tools for resilient preventative health and, instead, become structures that exploit CHWs, leaving them distressed and disillusioned within roles they are unequipped to fill and so fail to meet the needs of the communities they serve (Campbell et al., 2008; R. N. Labonte et al., 2017; Rifkin, 1996). The vital role CHWs are playing in the global COVID-19 pandemic requires us to highlight the failings of such scale-ups in the past and the key lessons we can take from this history.

Xenophobia in the ‘Rainbow Nation’: An Analysis of Intergroup Conflict in Contemporary South Africa Rachel Calcott

Since the inception of democracy in South Africa, the nation has been touted as an example of racial reconciliation and harmonious diversity. However, the xenophobic violence that has plagued the state since 2008 and resulted in hundreds of fatalities reveals deep
and ongoing intergroup divides. Dehumanizing rhetoric around immigration is propagated by both elected officials and the media, and non-natives are frequently characterized as ‘parasitic’ and ‘criminal.’ In this paper I suggest that the xenophobic violence observed in contemporary South Africa may be explained via a three-pronged analysis: the construction of an ‘exceptional’ South African social identity during the early years of democratic rule, the intergroup conflict instigated by job scarcity, and the mythologized scapegoating of migrant workers as an outgroup responsible for the lack of opportunity that persists despite majority rule.

The Impact of Climate Change on Security in the Middle East: A Review of the Literature
Yara El-Khatib

The Middle East, which is already plagued by a series of security threats—such as terrorism, religious conflict, political instability, and more—is also an increasingly water-scarce and climate change-vulnerable region. In this review, I examine the most recent and relevant literature on the debate of: how will, and how has climate change affected security in the Middle East? I organize them based on the extent to which they argue climate change is a precursor for insecurity in the region. While a few authors argue that climate change has or has not played a large role in the region’s insecurity, most authors argue that the debate is multi-faceted and complex, suggesting that climate change is just one of many factors—though still an important one—associat-

“Developing” Gender Equality: A Transnational Feminist Critique of International Development Theory and Practice
Caroline Crystal

Gender equality is increasingly understood as fundamental to international development, despite how the field differs from feminism in its intellectual tradition and ultimate goals. However, legitimacy, gender and understandings of gender equality are transnational and not global modalities, and even the most well-meaning institutions are not absent from global power relations or individual subjectivities. Often located in the “West,” international development organizations frequently make assumptions shaped by Western hegemony and therefore reproduce the very inequalities they claim to address. I explore the overlaps and asymmetries between transnational feminism and the gender equality programs of international development organizations such as the United Nations and the World Bank. These institutions and others like them reproduce hegemonic inequalities in three areas: first, imaginative geographies of power; second, understandings of gender and gendered subjects; and third, definitions of success in gender equality. For a truly transformative gender agenda, development organizations must recognize the politics of their locations, as well as the perhaps surprising extents and limits of transnational power and solidarity.

Barriers to the Diagnosis of Dyslexia in Children
Maria Elena Cunningham

Dyslexia is a learning disability that impairs reading, writing, and spelling and is estimated to affect 5-20% of people (Shaywitz, 1998; Shaywitz, 2003). Although dyslexia is a life-long disability that has no cure, evidence-based treatments are available for struggling students (Shaywitz, 2003). The earlier these interventions are implemented, the better the student outcomes (Alexander & Slinger-Constant, 2004). However, despite the very high prevalence of dyslexia and time-sensitive need for treatment, many affected individuals slip through the cracks and go undiagnosed until adolescence or adulthood — most never get diagnosed at all (Shaywitz, 2003). This paper addresses potential barriers that contribute to the underdiagnoses of dyslexia in children in the United States.
Sounding the Alarm: Down-Ballot Setback for the Democrats in 2020
Yaakov Huba

The 2020 general election turned out more American voters than any other election, its monumental stakes commanding the attention of the world. While the focus in the race’s aftermath has primarily been the top of the ticket, the rebuke of President Trump’s time in office, the equally important down-ballot races have been largely passed over. Many major political analysts like the Cook Political Report predicted that Democrats would expand their House majority by 5-10 seats. Yet, the Democratic Party ended up losing 10 seats (Wasserman, 2020). During the certification of election results, I collected data on incumbents in the US House of Representatives in their re-election bids. The paper examines performance of 2020 incumbents relative to 2018, and the factors which caused change in vote share. Findings suggest that the GOP had an even more successful down-ballot campaign than reported and highlights the absence of certain systemic factors once assumed to weigh heavily on incumbency advantage.

Troubles of the Coast: Industrialization, Climate Change, Marginality, and Collective Action among Fishing Communities in Kerala, India
Abigail Maher

This paper explores the ways in which small-scale fishing communities in Kerala, India are affected by both industrialization and climate change, how they respond to these challenges, and the spatial, political, and social context in which these communities are situated. In order to do this, a combination of primary source materials and scholarly work is utilized. Construction of small-scale fishing communities as culturally “primitive”, as well as caste prejudice on the part of the government and industrial fishers, has resulted in increased marginalization of fishing communities and increased difficulty in adapting to the adverse changes associated with both climate change and industrialization. Defying perceptions of fisherpeople as “backwards” and incapable of effective social and political action, fishing communities create recognition and interaction with government through effective community mobilization towards sustainable management of the common marine resources and action for addressing the negative environmental consequences of fishing industrialization and climate change.

“Our Neighbors In The Americas”: Obama, Empathy, and The Cuban Thaw
Sarah McKinnis

In the study of International Relations, there is growing research and consideration of the significance of empathy in political communications and nation-to-nation relationships. This article examines cognitive empathy, the ability to understand the perspectives and feelings of another, in the case of the Cuban Thaw, the reestablishment of diplomatic relations between Cuba and The United States. It traces President Obama’s use of empathy in publicly communicating intentions towards Cubans and Americans, a rhetoric that marks a contrast from the previous U.S. administrations’ attitudes toward Cuba. This article then analyzes the efficacy of that rhetoric, finding that though there are indications of positive effects, it is difficult to understand the long-term impact of his actions at this time. This case provides context as to the positive transformative power of empathy in IR, and the efficacy of empathetic rhetoric in shifting public attitudes and encouraging cooperation between previously antagonistic nations. Empathy as a tool faces a number of practical limitations, all of which deserve greater research and attention.
Decolonization: The Litmus Test of the Human Rights Framework

Isiuwa Omoigui

This literature review examines the complicated relationship between anticolonial activism and the human rights framework that emerged in the wake of the Second World War. I contextualize the scholarly debate on the tension between conceptions of human rights as an individual entitlement and the collectivist nature of African anticolonial struggles. The universalism of the human rights framework endures the harsh light of critique, given its emergence from the twentieth-century European experience of genocide and great powers’ competing commitments to democracy and empire. The crimes against humanity committed in the name of colonial conquest and rule challenge the great powers’ moral authority as arbiters of human rights. Varied contexts of anticolonial struggle, from Algeria to Cameroon, offer different answers to the question of the efficacy and applicability of the human rights framework. Ultimately, I look to indigenous praxis and epistemology as paths to liberation that is not merely nominal.

**Key words:** human rights, anticolonialism, self-determination

Social Media and the Construction and Propagation of Populist-Nationalist Discourse

Paula Pineda

The growing overlap between three important phenomena—the increasingly widespread use of social media (especially as a tool for political communication), the current populist zeitgeist (as described by Cas Mudde), and the rise of right-wing nationalism—make the question of how social media can be employed as a platform for the amplification of populist-nationalist discourse particularly pressing. This paper explores the affordances of social media that allow for its employment in the creation and propagation of populist-nationalist discourse, particularly the elective affinity between social media and populism, the way that social media can provide a platform for the emotive element of populist-nationalist discourse, and how social media can facilitate the amplification of conspiratorial thinking (characteristic of right-wing populism). To further elucidate this theoretical discussion, this paper will also explore Donald Trump’s online discourse surrounding the 2018 migrant caravan as a case study. Ultimately, this paper highlights how social media has provided an effective medium for the increasing interplay between nationalist and populist discourse.

Canines and Commons: An Institutional Analysis

Andy Xie

This paper applies Elinor Ostrom’s Institutional Analysis and Development Framework to explain how a local dog park – the Montrose – is able to overcome communal degradation in the absence of a centralized power. In the first half of this piece, I elucidate the rules, participants, and systems that characterize this specific social-ecological system. In the second half, through a combination of park-goer interviews and analyses of online reviews, I find that the existence of high degrees of social capital between participants, repeated interactions, entwined utilities, and the institutional diversity of a polycentric system serve to explain the effective maintenance, monitoring, and self-governance systems at the Montrose.

Shadow Banks, Money Market Funds, and Regulation: How Much is Too Much?

Ainsley Weber, Signidur Benediktsdottir

This paper examines the development of the shadow banking sector in the US leading up to the global financial crisis of 2007-2008. Shadow banking, or nonbank financial intermediation, consists of credit intermediation that takes place outside of the traditional banking sector. This can include off-balance sheet operations at banks and finance holding companies as well as operations at other nonbank financial companies. The paper reviews how shadow banking emerged as a result of regulatory arbitrage and the search for higher returns before considering how it contributed to the buildup of systemic risk leading up to the crisis. It specifically inspects the role of money market funds (MMFs) in supporting shadow banking. Finally, it engages with the reforms that emerged in the US in the wake of the crisis, concluding that more regulation is not necessarily the solution and advocating for a more holistic strategy geared towards oversight and supervision.

Access to Drinking Water and the Empowerment of Women in the Southwest Coast of Bangladesh: Intersections of Gender, Class, and Space

Sunehra Subah

The low-lying southwest coast in Bangladesh is one of the most vulnerable areas to the effects of climate change, with great water scarcity and high levels of arsenic and salinity. Women are the main accessors and users of water in this area due to their restriction to work in domestic spaces. Their gendered relationships to water in this area play a role in their empowerment and powerlessness. These relationships can be looked at through four examples of power: power over the body, power over mobility, power over decisions, and power over finance. It’s critical to consider the intersections of gender, class, and space in the extent of a woman’s power. The body, movement, political voice, and economic power of a wealthier woman will be policed differently than a poorer woman, and the space each woman occupies assists the process of empowerment differently.

An Upstander Is a Person in Your Neighborhood: Children, Sesame Street, and Race in 2020

Gemma Yoo

Educational children’s media, such as the program Sesame Street, may be the most accessible format for teaching young children about race and racism in the United States. Throughout its history, Sesame Street has attempted to confront racism through its diverse cast and, in the summer of 2020, by directly addressing the topic with children and families. However, both its passive representation and active discussion fall short of what is needed to confront systemic racism. This paper addresses Sesame Street’s past and present role as a leader in children’s educational media, and advocates that the program employ Critical Race Theory to evaluate how young children are taught about race.
Turning Science Fiction into Reality: Enhanced Motor Learning for Prosthetic Limbs
Makayla R. Conley

In science fiction, prosthetic limbs appear as seamless extensions of the human body that function as if the limbs were made of flesh and bone. With recent technological and scientific advancements, the prosthetic limbs of today are beginning to resemble those we once only imagined. Patients are now able to perform simple, everyday tasks like drinking from a glass of water. However, there are many limitations to this technology, including lack of fine motor movement, absence of reflexes, and missing sensory feedback from the prosthetic limb. These restrictions prohibit prosthetics patients from having the same experience as someone with a biological limb. This paper touches upon the limitations of prosthetics today and applies the findings of current neuroscience research to address these shortcomings to identify potential solutions and areas for further research.

Incomplete? Or Indefinite? Intuitionism on Gödel’s First Incompleteness Theorem
Quinn Crawford

This paper analyzes two natural-looking arguments that seek to leverage Gödel’s first incompleteness theorem for and against intuitionism, concluding in both cases that the argument is unsound because it equivocates on the meaning of “proof”, which differs between formalism and intuitionism. I argue that this difference explains why “proof” has definite extension for the formalist but not for the intuitionist. Sections 1-3 summarize various philosophies of mathematics and Gödel’s result. Section 4 argues that, because the Gödel sentence of a formal system is provable to the intuitionist, they are neither aided nor attacked by Gödel’s first incompleteness theorem. Section 5 concludes that the intuitionist’s notion of proof is indefinitely extensible.

Tail-Anchored Protein Insertion under ER Stress Conditions: Calcium is Key
Matthew Jordan, Malayalam Mariappan

Tail-anchored (TA) membrane proteins are critical for protein translocation, intracellular trafficking, and programmed cell death. TA proteins contain hydrophobic transmembrane domains and traverse through the cytosol to post-translationally insert into cellular membranes. It is unclear how this post-translational insertion is affected by Endoplasmic Reticulum (ER) stress. Here, we find that TA protein insertion is significantly reduced with ER stress inducer thapsigargin (Tg), a calcium pump inhibitor that blocks the import of calcium into the ER causing ER stress, but not when treated with other ER stress inducers. Interestingly, out data suggests that increased calcium in the cytosol may decrease TA protein insertion rather than ER stress. One potential mechanism for this is the calcium-dependent activation of chaperone, calmodulin, which acts like a trap for TA proteins under certain physiological conditions.

The Nature of Cofilin’s Severing Mechanism
Ethan R. Lester

Cofilin plays an essential role in regulating actin filament propagation through the cytoplasmic medium. Over the years, various studies have been conducted in an attempt to better understand the complex mechanism by which cofilin promotes filament severing and de-polymerization. Here, we have compiled information obtained from these studies in order to craft a more complete and succinct description of cofilin functionality. In particular, we review the precise structural and mechanical changes associated with cofilin-binding, and the subtle ways in which some of these structural changes may be interconnected.

Keywords: cofilin; F-actin; microfilament; twist; tilt; D-loop; flexural rigidity; torsional rigidity; mechanical asymmetry; filament-severing; de-polymerization

Strong Inclination Pacing of Climate in Late Triassic Low Latitudes Revealed by the Earth-Saturn Tilt Cycle
Miranda Margulis-Ohnuma, Jessica H. Whiteside, Paul E. Olsen

Gravitational interactions among masses in the solar system are recorded in Earth’s paleoclimate history because variations in the geometry of Earth’s orbit and axial orientation modulate insolation. However, astronomical models are unreliable before ~50 Ma due to the chaotic nature of the solar system and therefore must be constrained using geological observations. Here, we use environmental proxies from paleo-tropical Late Triassic lake deposits of the Newark Rift Basin to identify and tune to previously undescribed strong variations in orbital inclination. Tuning to the 173 kyr Earth-Saturn inclination cycle, theoretically stable due to the high mass of Saturn, reveals both other predicted inclination cycles and previously reported eccentricity cycles. Slight, complementary offsets in the eccentricity and inclination cycles shown by the Earth-Saturn (s3-s6) and Venus-Jupiter (g2-g5) tunings may be due to chaotic variations of the secular fundamental frequencies in Earth’s nodal and Venus’s perihelion orbital precessions. The strength of the inclination cycles suggests that the Earth system modulates orbital pacing of climate and provides a mechanism to further constrain astronomical solutions for solar system dynamics beyond the ~50 Ma limit of predictability.

Analysis of the Electronic Effects and Reactivity of Benzhydryl Ethers in the Formation of Benzhydryl Ethers
Katherine G. Quesada, Daniel Chabeda, Jaeger Johnson, Alex Shore

Benzhydryl ethers were synthesized through the use of microwave irradiation in a proto-ionic liquid solvent. The resulting products were separated from the reaction mixture by vacuum filtration with a silica gel plug. The products were analyzed using GCMS and 1H NMR techniques to identify and quantify products. Analysis of the resultant data indicated the syntheses of the desired benzhydryl products were successful for 4,4-dimethoxybenzhydryl (conversion: 83% (1-propyl ether), 11% (2-propyl ether), 11% (methyl ether)) and 4,4-dimethylbenzhydryl (conversion to desired product: 100% (1-propyl ether), 100% (2-propyl ether), 26% (methyl ether)). However, the syntheses were unsuccessful for
reactant 4,4-difluorobenzhydrol and benzhydrol. It was concluded that the electron-donating groups of 4,4-dimethoxybenzhydrol and 4,4-dimethylbenzhydrol aided in the formulation of a stable intermediate and subsequent desired product. The data support the hypothesized mechanism of protonation of the hydroxyl group of the benzhydrol with subsequent creation of a carbocation intermediate.

**Historical and Current Status of Hexabromocyclododecane as an Environmental Contaminant**
Rebecca Rubright

Hexabromocyclododecane (HBCD) is a brominated flame retardant added to industrial and commercial products. Due to its toxicity, threat to reproduction, and persistence in the environment, it was added to the Stockholm Convention as a prohibited substance in 2013. This review provides an overview of the compound, context to the 2013 decision, an update on the current usage of HBCD on the global market and a status report on HBCD as a persistent organic pollutant. It was found that while the use of HBCD is banned, it remains a threat to the environment and to organisms within it, including human beings, most importantly because it can impact fertility in females and negatively affects the development and survival of offspring. Construction laborers face the largest threat due to high levels of direct exposure, but there is evidence that the compound is already ubiquitous in the environment and within both terrestrial and marine foodwebs. More work is needed to determine the best course of action to remove this toxin from the environment.

*Keywords: hexabromocyclododecane, flame retardants, brominated flame retardants, persistent organic pollutants*
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