Bilateral Body Symmetry as Ableism:
A Comparative Case Study of
Grant's Atlas of Anatomy in 1962 and 2017

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M.A. Thesis in Disability Studies
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All figures are sourced from Grant's Atlas of Anatomy, 5th Edition and 14th Edition, unless otherwise cited.

INTRODUCTION

I am a dance artist by training and deeply committed to questions of movement and subjectivity. A study of movement evinces that there exists an infinite number of ways to get from here to there, from the ground to standing, from the beginning to the end. There is no one way—no matter how many times a routine or procedure is repeated. Similarly, disability has the tremendous capacity to demonstrate a multitude of methods for living, for doing, and for being. While architecture and environments have been created by and in support of non-disabled bodies, disabled people show the seams in an otherwise ableist world. Disabled people demonstrate this through experience, communication, and activism. In "Storm Readings," playwright Neil Marcus puts it simply: "Disability is an art. It's an ingenious way to live" (Marcus, 1997).

As a non-disabled person, I work continually to attune myself to the ways, large and small, that my body, my thinking, and my practices deviate from a perceived norm—often in service of personal comfort, ease, and preference. This is a direct counter to the socialization I have been taught implicitly and explicitly as a non-disabled person. Disabled people are often more alert to these shifts as they create strategies in order to live with comfort, ease, and agency in spaces and societies built without disabled bodies in mind. This practice of tuning in and noticing myself and my environment has been activated because of my study of disability.

A practice of noticing my own material, its nuances, its strangeness, its mundanity led me to my current inquiry regarding symmetry and asymmetry. I have different rotation in my neck when looking to the right and left. When I do a push-up, my elbows point in very different directions. I wear through shoes at different rates. While these asymmetries have perhaps been developed over time, some asymmetries seem life-long. For instance, my two eyes are slightly

different sizes. I have only ever gotten ear infections in my right ear, never the left. My armpits produce distinctly different body odors. I am right-hand dominant. I am not symmetrical. Why did I ever think I was?

Some human bodies may appear symmetrical on a superficial level, but beneath the surface, the body is fundamentally asymmetrical. In a New York Times article, "Growing Left, Growing Right," science writer Carl Zimmer (2013) describes fetal organ development,

> The heart shows the first visible asymmetry. Starting out as a simple tube, it loops to the left. The heart then starts to grow different structures on each side, producing the chambers and vessels required to pump blood. Meanwhile, other organs start moving. The stomach and liver each move clockwise away from the midline of the embryo. The large intestines sprout an appendix on the right. The right lung grows three lobes, the left only two.

The human body has a logic that is not as neat nor simple as bilateral symmetry. The asymmetry of the human body ranges from highly visible to invisible and this experience may or may not intersect with an experience of disbility.

An investigation of symmetry has direct implications for medical training, because symmetry is embedded in training methods for many medical and physical practices. For example, many medical textbooks map out the muscular or skeletal or nervous system on one side of the body, thereby asking the student to generalize this knowledge to the other side of the body (Papadakis, 2016; Gray, 1985). This practice assumes that one side of the body can be mapped onto the other. While these body halves may have similarities, they certainly have distinctions as well. To look directly at this issue, I conduct a case study of two editions of an anatomical medical text to trace this transmission over different time periods.

This paper examines and questions the way symmetry is mechanized in two editions of a prominent anatomical text, *Grant's Atlas of Anatomy*. This text is assigned to many North American medical students in the early years of their training, including first year students at Duke University, University of Southern California, Wake Forest, and University of Illinois ("Course Information"; Habib, n.d.; "MD Curriculum"; "Phase 1 Recommended Textbooks and Materials"). The depictions within *Grant's Atlas of Anatomy* visually demonstrates how symmetry has been automated to indicate ideas about the body. Importantly, these mechanizations shift over the years—demonstrating how unfixed the concept of symmetry is in practice. To consider this change, two texts are considered: an edition from 1962 and an edition from 2017. From these texts, I search to better understand how symmetry is implicitly used to convey medical knowledge and how this interacts with both disability and ableism. Using *Grant's Atlas of Anatomy* as a case study, this paper examines how can a Disability Studies perspective challenge the use of bilateral human symmetry.

LITERATURE REVIEW

The history of drawing human anatomy is a long history, colloquially speaking, and a short history, legally speaking. While some have scholars pointed to cave drawings as the earliest example of anatomical drawing, the earliest published work that depicted human anatomy is widely considered to be by Claudius Galenus, also known as Galen of Pergamom, in the 2nd Century. Galen based his depictions of human anatomy of non-human animals, to follow the rules that governed the Roman Empire. His speculative drawings were surpassed by Andreas Vesalius in 1543, who published *De Corpus Fabrica Humani* and based his drawings on posthumous dissections. Dissection was a practice initiated by Herophilus in Egypt, but most vividly depicted by the Greeks and Romans (Loechel, 1964, p. 169). Vesalius set a new standard for the field with his books that detailed the following areas of anatomy: bones and cartilages, ligaments and muscles, veins and arteries, nerves, organs of nutrition and generation, heart and associated organs and the brain (Vesalius, 1998). Vesalius relied on dissection because he lived under rule that prohibited drawing in conjunction with surgery or live subjects. The researcher found no documentation of published medical illustration that did not follow the laws of its time.

Prior to the work of Galen of Pergamom, in approximately 30 BC, the Roman architect Marcus Vitruvius Pollio published ten books on foundational concepts in architecture, the logic of which was often applied to the human body by medical illustrators and artists. The work of Vitruvius were the only on the subject to survive antiquity. In Book III titled, “On Symmetry: in Temples and in the Human Body,” Vitruvius drew connections between the proportions of a building and a human body, asserting that symmetry must be principal to design for the “well shaped man” (Vitruvius, 2006). Vitruvius endeavored to link proportion with symmetry and human anatomy with built architecture when he stated, “in the human body there is a kind of

symmetrical harmony between forearm, foot, palm, finger, and other small parts; and so it is with perfect buildings" (Vitruvius, 2006). His work is integral to understanding early thinking around anatomy and human proportions, and his work later inspired artists like Leonardo da Vinci or Polykleitos to represent these ideas visually.

Albrecht Dürer modeled much of his writing in the legacy of Vitruvius. In 1528, he published *Four Books on Human Proportion* which discussed symmetry—though he never uses this term outright. Like Vitruvius, Dürer divided the human body into fractions. Vitruvius created mathmatical formulas to standardize the proportions of the body. For example, he stated, "[t]he length of the foot is one sixth of the height of the body; of the forearm, one fourth" (Virtuvius, 2006). Dürer built complexity into these formulas by developing ways to represent movement and both concave and convex features of the body (Panofsky, 1955). Unlike Vitruvius, Dürer designed models for male and female bodies, with distinctly different proportions across the perceived sexes. Mathmatician Hermann Weyl interpreted that Dürer had a different orientation towards normalcy and symmetry. Dürer perceived his canon of the human figure as more of a standard from which deviation is expected (Weyl, 2016, p. 65). This contrasts significantly with theorists who believe symmetry is an objective standard towards which to strive.

Medical illustration shifted immensely with the advent of the printing press and, later, the introduction of degree-granting programs. As publications became industrialized, more artists emerged and more texts were produced. Max Brödel is widely cited as a pioneer in medical illustrations who advanced a technique that utilized carbon dust to increase the accuracy of his drawings. This technique, which was easily replicable, offered an alternative to the lack of detail formerly produced by etching (Crosby & Cody, 1991). Brödel, along with scientists, produced

several medical texts and went on to create the first degree-granting program in the United States for medical illustrators, now called the Department of Art as Applied to Medicine, based at the Johns Hopkins School of Medicine ("History & Archives"). These practices allowed for the enumeration of medically illustrated texts and the proliferation of medical illustrators.

As medical illustration became codified and mass-production increased, more anatomy texts were produced, including *Gray's Anatomy*, *Netter's Atlas*, and *Grant's Atlas*. *Gray's Anatomy*, first published in 1858, is now in its 41st printing and is widely considered to be the most comprehensive anatomy text available in English. While the imagery in *Gray's Anatomy* is highly detailed, it is primarily considered a reference book for practicing surgeons. *Netter's Atlas*, created by a medical illustrator with an M.D., is a more recent addition to the canon of medical illustration. The first edition was published in 1989. As an atlas, *Netter's Atlas* focuses primarily on drawings, images, and diagrams. Similarly, *Grant's Atlas* aims to impart foundational visual information more than didactic theoretical knowledge.

Grant's Atlas was selected as the case study for this paper for several reasons. First, this text was most available to the researcher. Second, this text is an atlas and not a reference book, so the researcher can focus primarily on the application of symmetry in diagrams and imagery. Third, this atlas is aimed at beginning medical students, which affords the researcher (who is without medical training) access to this foundational knowledge. Fourth, this particular atlas has been produced and re-produced for several editions and is currently on its fourteenth re-printing. This process allows the reader to witness that significant change occurred in the time period between these editions. Lastly, *Grant's Atlas* explicitly acknowledges its use of plane symmetry in its medical diagrams, which is a primary focus of this research.

In this paper, two editions of Grant's Atlas are interpreted through a Disability Studies lens to question how symmetry functions within medical illustration. Symmetry is a mathematical concept explored by Hermann Weyl in his seminal text, *Symmetry*. Weyl identifies symmetry as a relational concept which indicates corresponding proportions in relation to an axis, line, or point (Weyl, 2016). These types of symmetry are often referred to as rotational symmetry, point symmetry, and plane symmetry. Rotational symmetry is demonstrated when a structure displays a repetitive appearance following a rotation or partial rotation. Point symmetry is demonstrated by a structure where all features are equidistant from a shared point. For example, the capital letter "H" has point symmetry from a central point. Though the body contains structures that display versions of rotational and point symmetry, this paper does not focus on these variants. Instead, a specific type of plane symmetry is considered within this paper—bilateral symmetry. Bilateral symmetry is the specific term assigned to objects or beings that are divisible into symmetrical halves along a midline or center plane.

An example of an object that is bilaterally symmetrical, at least on the surface, might be the Taj Mahal in India. The building is proportioned identically in relation to its central axis. Architecture on the right side of the building is mirrored on the left. Each minaret is the same distance to the midline and looks like the reflection of the minaret directly across from it. However, if one were to cut the Taj Mahal open and look inside to determine if it has two symmetrical halves (as the definition suggests) we may not think the building is entirely symmetrical. There may be more people on one side of the building than the other. The wear of footsteps might be more pronounced on one side. The building's natural erosion might be more progressive on one side and the paint could be chipping on the other. Further, the building was created by humans. While such a building may appear superficially symmetrical when viewed

from a distance, it is probably less perfect when one considers human nature and looks at the building in close range.

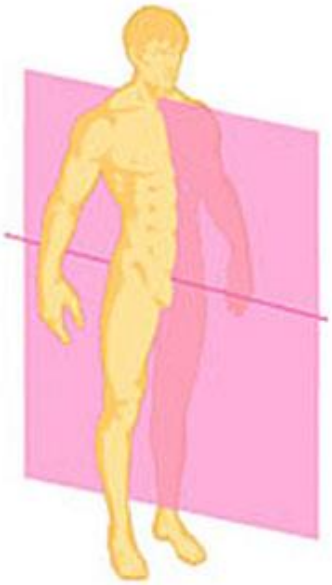

Figure 1, Diagram of Sagittal Plane (Walden, 2019)

In the human body, bilateral symmetry is understood relative to the sagittal plane of the body. As seen in Figure 1, the sagittal plane is an imaginary boundary that divides the right body from the left and runs perpendicular to the ground. If the body is indeed bilaterally symmetrical, then all proportions and structures of the body would be reflected across the sagittal plane onto the other half of the body.

Though symmetry itself is a design concept without any inherent value, symmetry can carry cultural value in certain contexts. Even Hermann Weyl, a mathematician whom one may expect to be impartial regarding cultural matters, has a culturally-informed view of symmetry. He describes bilateral symmetry as "so conspicuous in the structure of higher animals, especially the human body" (Weyl, 2016, p. 4). While Weyl offers critical information regarding the framework of symmetry, his viewpoints come pre-loaded with bias. He unequivocally presumes that the human body is symmetrical and further, he implicates the function of symmetry in the world. According to Weyl, "[s]ymmetry, as wide or as narrow as you may define its meaning, is one idea by which man through the ages has tried to comprehend and create order, beauty, and perfection" (Weyl, 2016, p. 5). While Weyl's work offers insight into the mathematical reasoning that grounds concepts of symmetry, he does not offer viewpoints that question the dominant social narrative of his time. Instead, he upholds symmetry as a truism of the human body—thereby exalting particular bodies and, conceivably, not others.

At the outset, it may seem reasonable to deduce that humans are symmetrical beings. Most have two arms, two eyes, two legs, with one on either side of a dividing center line. This presumed symmetry has been represented in media from magazine ads to medical journals. Many studies have been conducted to correlate symmetry to seemingly advanageous traits, such as facial beauty (Penton-Voak, et al, 2001; Scheib, et al, 1999), attractiveness (Tovée, et al, 2000), immunoefficiency (Dongen & Gangestad, 2011; Pawlowski et al, 2018), and body odor (Rikowski, 1999). These studies evince a cultural yearning for symmetry and an insistence that a symmetrical body exists. In each study, it is presumed that symmetry itself is a desirable trait—an indication of a human's potentiality. However, none of these studies paused to consider the embedded assumption at work in this logic. Symmetry, perfect symmetry, is impossible.

To challenge which bodies are privileged and which are not, several Disability Studies scholars inform this research and influence this case study. Writers such as Lennard Davis, Arthur W. Frank, and Rosemarie Garland-Thomson propose alternate modes of embodiment and in doing so, disrupt biased notions of human value. Lennard Davis questions the concepts of normal and normalcy to demonstrate how these notions have been created over time to falsely assert that a majority of individuals cling close to some idea of center. Davis argues, "the 'problem' is not the person with disabilities; the problem is the way that normalcy is constructed to create the 'problem' of the disabled person" (Davis, 1995, p. 24). When human diversity is taken into account, it becomes clear that there is no norm and there is no average. The idea of norm is created to privilege some and harm others. While social statistics may seem like a benign description of a population, they are often used to coerce, compel, and create a type of normalcy. Each person's experience is unique and individuated. Instead of a bell-curve, humans are more like a scatterplot. All people are in relationship and there are overlaps in experiences,

but they are not on the same slope or parabola or axis. This paper seeks to examine one facet through normalcy functions and persists: through ideologies of bodily symmetry.

Though his work pre-dates the formation of Disability Studies as a scholarly field, Michel Foucault's *The Birth of the Clinic: An Archaeology of Medical Perception*, first published in 1963, lends context to the medical framework that foregrounds the texts analyzed in this paper and the medical industry altogether. Foucault places a historical framework on medicine to question its development as an industry in the 19th century and coins a term translated by A.M. Sheridan as the *medical gaze*. Foucault continually challenges the premise of empiricism that is embedded within medical practice and supposes that knowledge about the body is not inherent but instead designed through language, which is sodden with power (Foucault, 1976, p. 3). Foucault (1976) explains,

> At the beginning of the nineteenth century, doctors described what for centuries had remained below the threshold of the visible and the expressible, but this did not mean that, after over-indulging in speculation, they had begun to perceive once again, or that they listened to reason rather than to imagination; it meant that the relation between the visible and invisible—which is necessary to all concrete knowledge—changed its structure, revealing through gaze and language what had previously been below and beyond their domain. (p. xii)

This changing structure identified by Foucault points to the discursive strategies, like textbooks, to disseminate knowledge in an evolving field of medicine. These strategies are not empirical, but created in the nineteenth century by particular bodies with tremendous power. Foucault also acknowledges the extraction of narrative in the dissemination of medical knowledge. In a

moment of provocation, he speaks assuming the role of a medical professional, "[i]f one wishes to know the illness from which he is suffering, one must subtract the individual, with his particular qualities" (Foucault, 1976, p. 35). Foucault's writing offers historical context for many notions about the body that might otherwise be presumed timeless or neutral. Foucault contests ideas considered empirical and proposes that medical knowledge is culturally created at particular historical moments.

In the tradition of Foucault, Arthur Frank describes the reduction of personhood that is often employed to produce medical and scientific knowledge in *The Wounded Storyteller*. This reduction comes at a cost, because it eliminates subjectivity and humanity from its outcomes. Frank (1997) shares a personal account to illuminate this perspective,

> As I looked at the article I realized his name was not mentioned. Probably the surgeon and the journal would have considered it unethical to name him, even though pictures of the man were shown. Thus in 'his' article he was systematically ignored as anyone—actually anything—other than a body. But for medical purposes it was not his article at all; it was his surgeon's article. This is exactly the colonization that Spivak speaks of: the master text of the medical journal article needs the suffering person, but the individuality of that suffering cannot be acknowledged. (p. 12)

In standardizing the human body, whether through medical illustration or a surgeon's article, the individual nature of a particular body is eliminated from the final product. In striving for standards, norms, and simple diagrams, Frank argues, personhood is lost. Readers are unaware of the individual's identity, history, quirks, or talents. Without the individual account, personalized details are kept from transmission.

Rosemarie Garland-Thomson seeks to redistribute cultural authority from non-disabled people and re-inscribe the embodied intelligence that disabled people bring to the world. In her book, *Extraordinary Bodies: Figuring Physical Disability in American Culture and Literature*, she asserts the value of disabled bodies by questioning the historic distinctions between ordinary and extraordinary bodies. Garland-Thomson claims that coding certain bodies as deviant or defective only serves to privilege bodies deemed normal or average. She uses examples of disabled bodies in culture and literature, such as Tiny Tim in Dickens's *A Christmas Carol*, to "reveal the physically disabled figure as a culturally and historically specific social construction" (Garland-Thomson, 2017, p. 41). To understand deviant bodies coded as *extraordinary*, Garland-Thomson examines the utility of average, especially in the context of disability. She says, "the multiply measured average man embodied humanity's regularity and stability, around which particularities ranged on a short leash" (Garland-Thomson, 2017, p. 64). Garland-Thomson recognizes that average is a limited and limiting concept. Like Frank, Foucault, and Davis, Garland-Thomson's work offers a perspective that revises and reimagines the assumptions put forth societally and by medical professionals. These scholars offer routes and methods that are not limited to the medical viewpoint and moreover, they assert the necessity of examining any instance where the human body is standardized or normalized.

By placing scholarship from Disability Studies in conversation with medical textbooks and illustration, a friction will undoubtedly emerge. Scholars of Disability Studies disbelieve that there is any singular way to have a body. Disability Studies disrupts concepts that have become automated within culture and asks its pupils to recognize its social construction. In contrast, medical training aims to impart knowledge as quickly and effectively as possible, which can thereby erase the singularity so important to someone like Lennard Davis. This investigation of

bilateral symmetry in medical atlases endeavors to point out instances where cultural logic and societal value has become embedded in medical training and in doing so, disrupt notions of average, normal, and symmetrical.

METHODS

While symmetry is a concept present in many aspects of everyday life and certainly interacts with major concepts forged through Disability Studies, there is yet to be any scholarly literature that explicitly considers how this concept impacts the body and knowledge produced about the body. It is for this reason that this research has been designed as a case study. After a year of searching, the researcher did not encounter any scholarly work that speaks directly to this topic. Therefore, there is little comparative or contextual data available. A case study does not heavily rely on prior scholarly work and instead charts its own path, based on specific findings, synthesis, and analysis. This method was determined because it offered a direct route into building more literature that considers symmetry from a Disability Studies perspective. A case study produces data that can fill the existing scholarly gap regarding bilateral symmetry as a mechanism of ableism.

The case study performed in service of this paper is qualitative, comparative, and hermeneutic. Grounded in the social science of Disability Studies, this scholarship is qualitative because it looks at trends, values, and meanings to derive analysis. Qualitative research requires subjectivity through personal accounts and perspectives to ask questions such as why and how. This is in contrast to quantitative research that seeks amounts and numbers to substantiate findings. This qualitative research is comparative in its approach. Instead of examining a singular research subject, this paper examines two texts and considers their similarities and differences. The inquiry is hermeneutic—a methodology that readily acknowledges the impossibility of a neutral researcher and instead accepts that research is inherently interpretative and as such, subject to the expertise, flaws, privileges, and embodiments experienced by the researcher. This particular research considers embodiment, which is not neatly articulated through language.

Verbalizing a non-discursive experience, such as an embodied sensation of asymmetry, is inherently an act of translation (and therefore interpretation). The hermeneutic research style acknowledges that there is always failure in an act of transmission and asks that research reflect and respond to this process (Patton, 2015). In order to respond to the needs of the Disability Studies field and the particular responsibilities outlined in this research project, this paper will employ a comparative case study that reflects the positionality of the researcher.

To carry out this research, two editions of *Grant's Atlas of Anatomy* are considered and analyzed: the fifth edition from 1962 and the fourteenth and most recent edition from 2017. These editions were selected for their availability to the researcher and because they are from different time periods. Both texts are examined and evaluated individually prior to their collective consideration.

The researcher considered both text and visual imagery and then coded for themes related to symmetry in medical illustration. Coding occured in five main categories: aesthetic, organization, context, content, and symmetry. Within each category existed subcategories. Aesthetic coding explored size, use of color, and text. Organizational coding considered book formatting, page formatting, and sequencing. Context coding examined the related content provided in each text, including the cover image and the acknowledgement section. Content coding explored the information conveyed through imagery such as diagrams, charts, and photographs. While symmetry could exist within the category for content, it was isolated as its own category for coding as it is the focus of this paper. Symmetry coding considered the side favored (if there was one), acknowledgement of this practice, and any secondary implications resulting from the mechanization of symmetry.

Each area of coding produced a category through which deeper conclusions may be drawn. After examining each text separately, themes and codes were compared to better understand similarities and variations. The goal of this examination was and is to better understand the utility of symmetry in medical illustrations and how this has shifted over time. The research methods have been designed to reflect the changing nature of publishing empirical knowledge, the changing subjectivity of the researcher, and the values of a research project grounded in Disability Studies.

ANALYSIS

Grant's Atlas of Anatomy has been demonstrating the contours, connections, and forms of the human body since its first publication in 1943. Each atlas contains medical illustrations of the human body and is divided into chapters which highlight various systems and structures. Since its initial publication 76 years ago, there have been fourteen subsequent editions. Each edition has been revised to reflect increased technological capacity, such as detailed surface anatomy photos, and the evolving needs of the medical student, such as electronic flash-cards. While early editions of the text demonstrate assumptions about bilateral symmetry in the human body, newer editions seem less reliant on this ideology. To give context to earlier editions, the fifth edition of *Grant's Atlas of Anatomy* is analyzed. To offer insight into more recent iterations, the fourteenth edition is also analyzed.

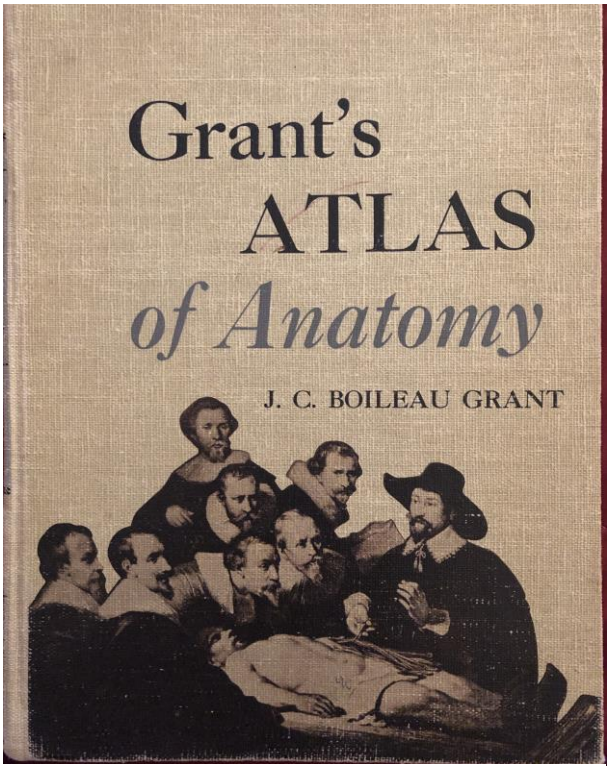

Figure 2, Cover of *Grant's Atlas*, 1962.

Grant's Atlas of Anatomy, 5th Edition

The fifth edition of *Grant's Atlas of Anatomy*, published in 1962, affords the reader an understanding of the ideologies at work in early editions of the atlas. The fifth edition clues its reader into its particular bias with the cover alone (Fig. 2). Eight white men wearing dark clothes with wide, white collars gaze towards a man, similarly dressed, with a broad, black hat who directs an instrument towards the loosely-clothed cadaver of a white man whose left arm is dissected and splayed. The race and gender

disclose the reality of the medical profession in the time of its publishing: the majority of surgeons were indeed white men in 1962. In fact, the American Medical Association still reports that the most male-dominated medical fields continue to be surgical specialties (Murphy, 2019). According to the cover image, *Grant's Atlas of Anatomy* is steeped in the ideology of its time.

Much of the contextual information for the fifth edition of *Grant's Atlas of Anatomy* lives within it opening preface. The drawings throughout the atlas were produced by medical artists, one of whom, Dorothy Chubb, was a pupil of Max Brödel. These artists derived their drawings from photographic negatives and tracing paper, which were later transferred to paper suitable for publishing and scrutinized against the original specimen. According to Grant, "little, if any, liberty has been taken with the anatomy; that is to say, the illustrations profess a considerable accuracy of detail" (Grant, 1962, p. vii). In addition to acknowledging the medical artists, Grant also thanks his university colleagues and his publishers—a gesture that will shift and expand in later editions.

Most relevant to this particular research, the fifth edition preface highlights its use of symmetry and praises its advantageous nature for the reader. The preface states, "In order that the student may be able to turn the pages and study figure after figure without requiring to re-orient himself, all illustrations of bilaterally symmetrical structures are from the right half of the body unless otherwise stated" (Grant, 1962, p. vii). Not only does this statement, on the very first page of text, embed the assumption that the body holds bilaterally symmetrical structures, it also mechanizes this ideology, purportedly, for the reader's benefit. Throughout the book, figures are shown on the right side alone (see Fig. 3.1, 3.2, and 3.3). The reader is thereby required to imagine and interpret the left half of the body as a mirror to the right. According to the preface, symmetry is mechanized for the reader's benefit and there seems to be no equivocation that the

body is bilaterally symmetrical. In this ideology, the selection of the right side appears arbitrary and there is no writing that indicates how this side was chosen. Perhaps Grant himself was right-hand dominant. Perhaps the medical illustrators found it easier to portray a right body part over the left. Though the reasoning behind this selection is unclear, it reveals a tendency by the authors to make assumptions about what's best for the reader and in doing so, assumes that the body itself is symmetrical.

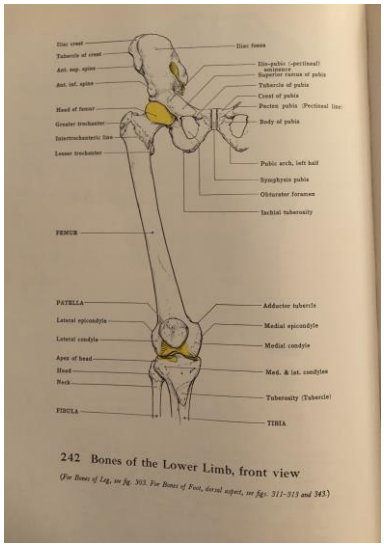

Figure 3.1, Bones of Lower Limb

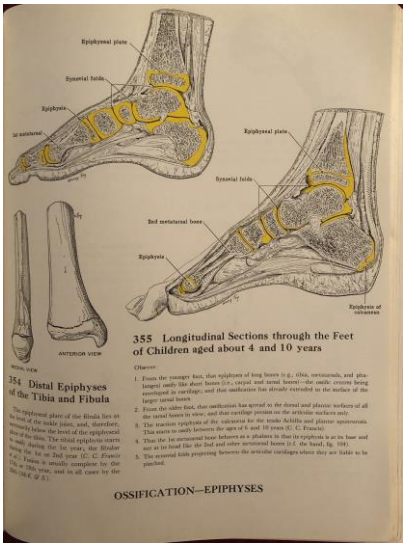

Figure 3.2, Ossification—Epiphyses

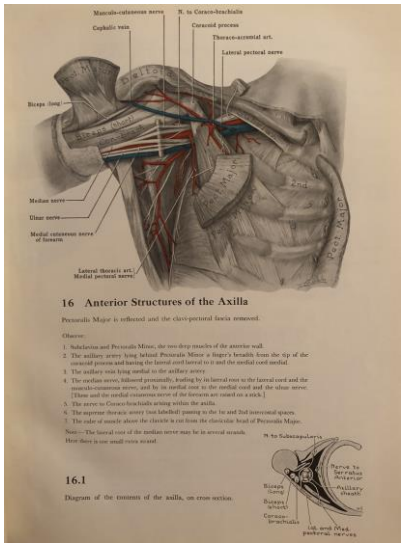

Figure 3.3, Anterior Structures of the Axilla

Throughout the text, exceptions are highlighted to distinguish particular cases that a surgeon may encounter or that are not already outlined within a diagram. These special cases are necessary to the design of the text, because the atlas itself standardizes both typical bodies and perceived deviations from this norm. Instead of depicting the particularities and peculiarities of many bodies, the fifth edition of *Grant's Atlas of Anatomy* attempts to standardize the body and in doing so, necessitates subsections titled, "Variations and Anomalies." These sections relegate experiences of disability into subsections and footnotes, thereby centering non-disabled experiences and treating disability as deviation from this created norm. This is showcased in

Figures 4.1, 4.2, and 4.3, wherein special examples are highlighted that are not otherwise contained within a diagram or drawing. The rationale behind the book's organization is never directly stated. However, the organization of the chapters is created, in part, through the mechanization of symmetry, which pushes disability out of its main content and into its subsections.

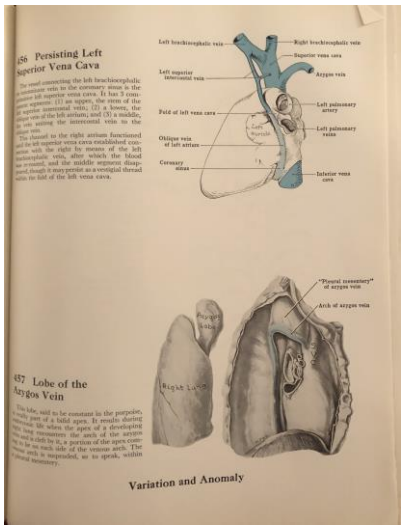

Figure 4.1, Variation and Anomaly

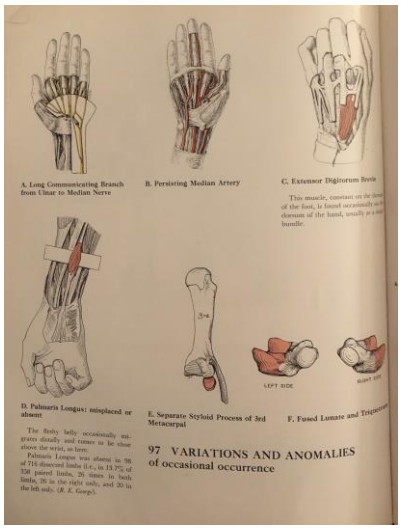

Figure 4.2, Variations and Anomalies of Occasional Occurence

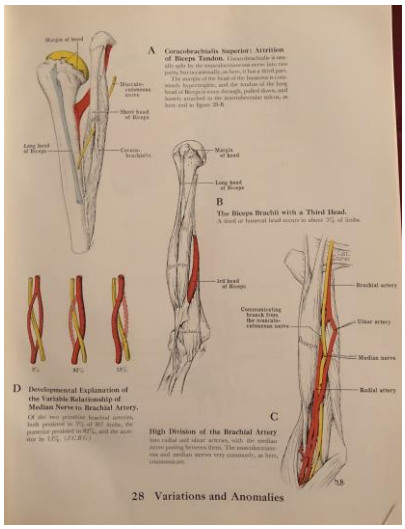

Figure 4.3, Variations and Anomalies

Grant's Atlas of Anatomy, 14th Edition

In 2017, the fourteenth and most recent edition of *Grant's Atlas of Anatomy* was published. The cover of the fourteenth edition tells a story of evolution for *Grant's Atlas*. As seen in Figure 5, the cover includes a frontal cross-section of the abdomen, displaying the muscles, arteries, veins, and organs therein. On the lefthand side, the depiction demonstrates the older techniques used to convey the body including carbon dusting and inscriptions on the organs, instead of outside the diagram. Perhaps most importantly, the drawing is in greyscale. On the righthand side, across an imperfect divide that conjures the image of a torn page, a more modern depiction is shown. On this side, the cross-section is in full color and the anatomy appears to be computer-generated instead of hand-drawn. The cross-section of the abdomen

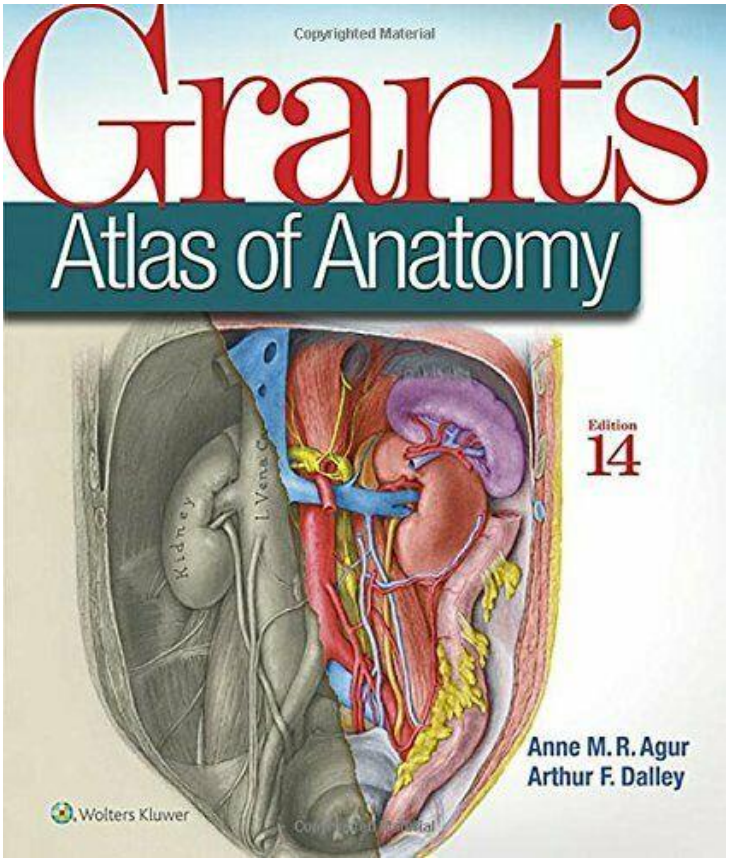

Figure 5, Cover of *Grant's Atlas,* 2017.

contrains styles witnessed in both the fifth and fourteenth editions of *Grant's Atlas of Anatomy*. The cover tells a visual story of where the text began and where it is now.

As Grant died in 1973, this text was published with his name in the title, but not as a contributing author. The fourteenth edition was authored by Anne M.R. Agur and Arthur F. Dalley II and includes a short biography of Dr. Grant. The atlas acknowledges 42 reviewers who are students, medical practitioners, and medical school faculty. While both editions acknowledged the collective effort that contributed to the atlas, the more recent edition acknowledges a greater number of individuals and includes students as stake-holders in this project. It is possible that the changes in collaboration across multiple editions may have contributed to different outcomes in the various textbooks.

The fourteenth edition offers many opportunities to orient a reader. In addition to a table of contents at the start of the book, each chapter includes an overview of its subsections on its first page. Colors are used in systematic ways to make connections between regions or direct the reader's eye to a corresponding images. For example in Figure 6, a photograph of a right leg has a superimposed yellow line to highlight the location of the Tibial nerve. On the corresponding

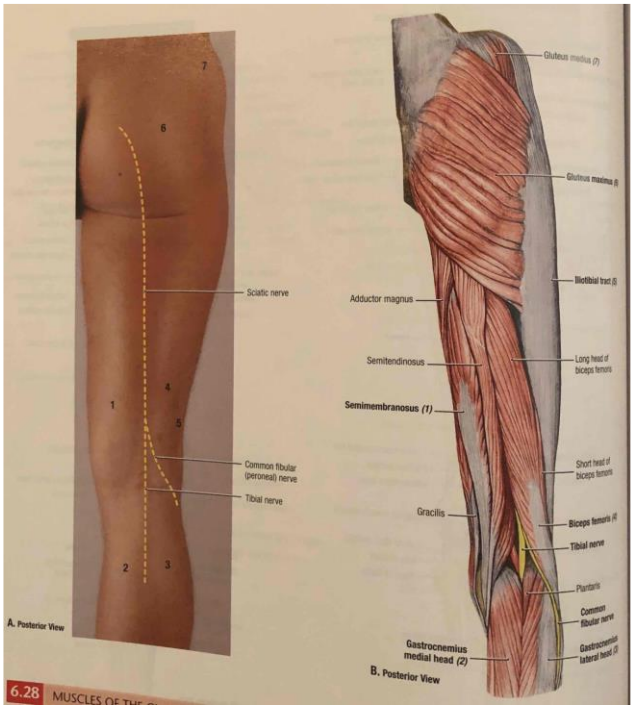

Figure 6, Example Corresponding Colors

diagram, the Tibial nerve is highlighted in yellow (Agur & Dalley, 2017, p. 500). Photographs are included beside drawings and diagrams assist the reader in understanding the nuances of superficial and deep anatomy. As demonstrated in Figure 6, a photograph and a diagram are paired together to offer multiple understandings of the right hand, thus inviting diverse learners to engage with the matieral. Each page is organized like the one before and the one after: a heading appears at the top with a title and page number and at the bottom, textual notes on the diagram. The medical imagery takes up most of the page.

Considering Both Editions

Between the fifth and fourteenth editions of *Grant's Atlas of Anatomy* many of the aspects that remained unchanged were discovered through analyzing the texts for their design and organization. The design of the book itself appears the same dimension across editions, with pages that are 9 inches by 10.5 inches. The text is sequenced region by region, designed to be encountered "in much the same order as the student displays them by dissection" (Grant, 1962, p. vii). The books contain the same sections: Back (also called Vertebrae and Vertebral Column), Upper Limb, Lower Limb, Thorax, Abdomen, Pelvis and Perineum, Head, Neck, and Cranial Nerves. The font size did not change drastically between editions and the pages were organized

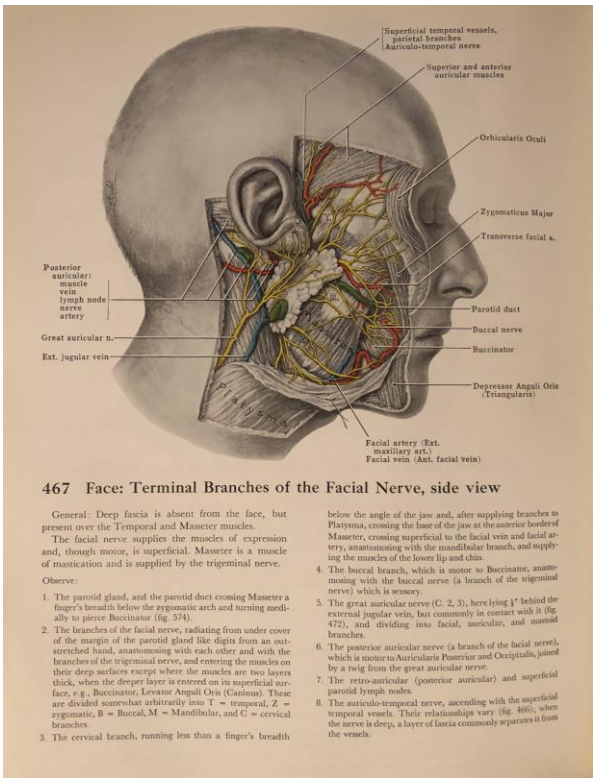

Figure 7, Example of Carbon Dusting

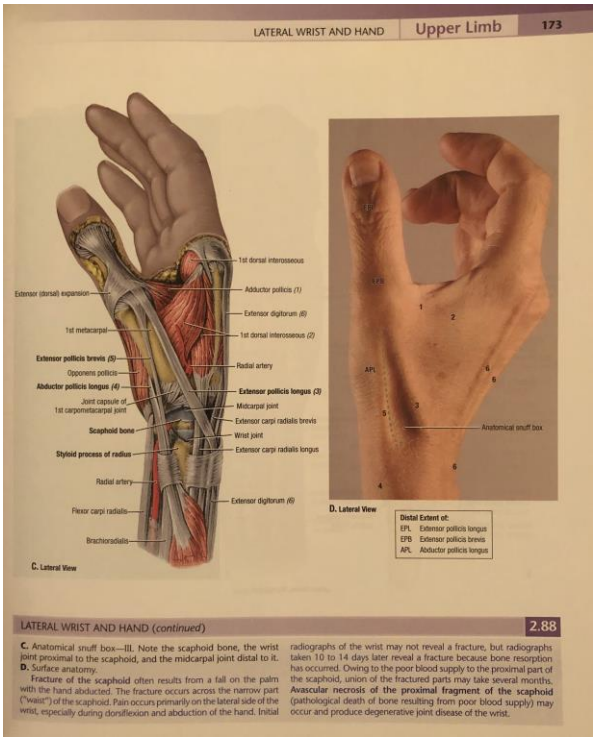

Figure 8, Example of Photograph

with imagery taking up most of the page and text taking up less space. Though there were many strategic changes that occurred between these two editions, some basic features of the book remained the same.

Between the fifth and fourteenth edition, several elements changed, ranging from stylistic alterations to philosophical transformations. Some changes simply reflected the availability of their time period. For example, the fourteenth edition is entirely in color whereas the fifth edition was only partially in color—it was primarily in grey-scale using a technique called carbon dusting (Fig. 7). The fourteenth edition includes photographs (Fig. 8) whereas the fifth edition only included drawings and diagrams. The drawings in the fourteenth edition have been designed using a computer and the drawings in the fifth edition were done by hand. All text in the fourteenth edition is typed. Typeface in the fifth edition was inconsistent. It was sometimes handwritten and sometimes in varying fonts. At times, terms were written into the diagram itself

in the fifth edition (for example, see Fig. 9). In the fourteenth edition, all terms are written outside the diagram with a line indicating the body part being identified. In the fourteenth

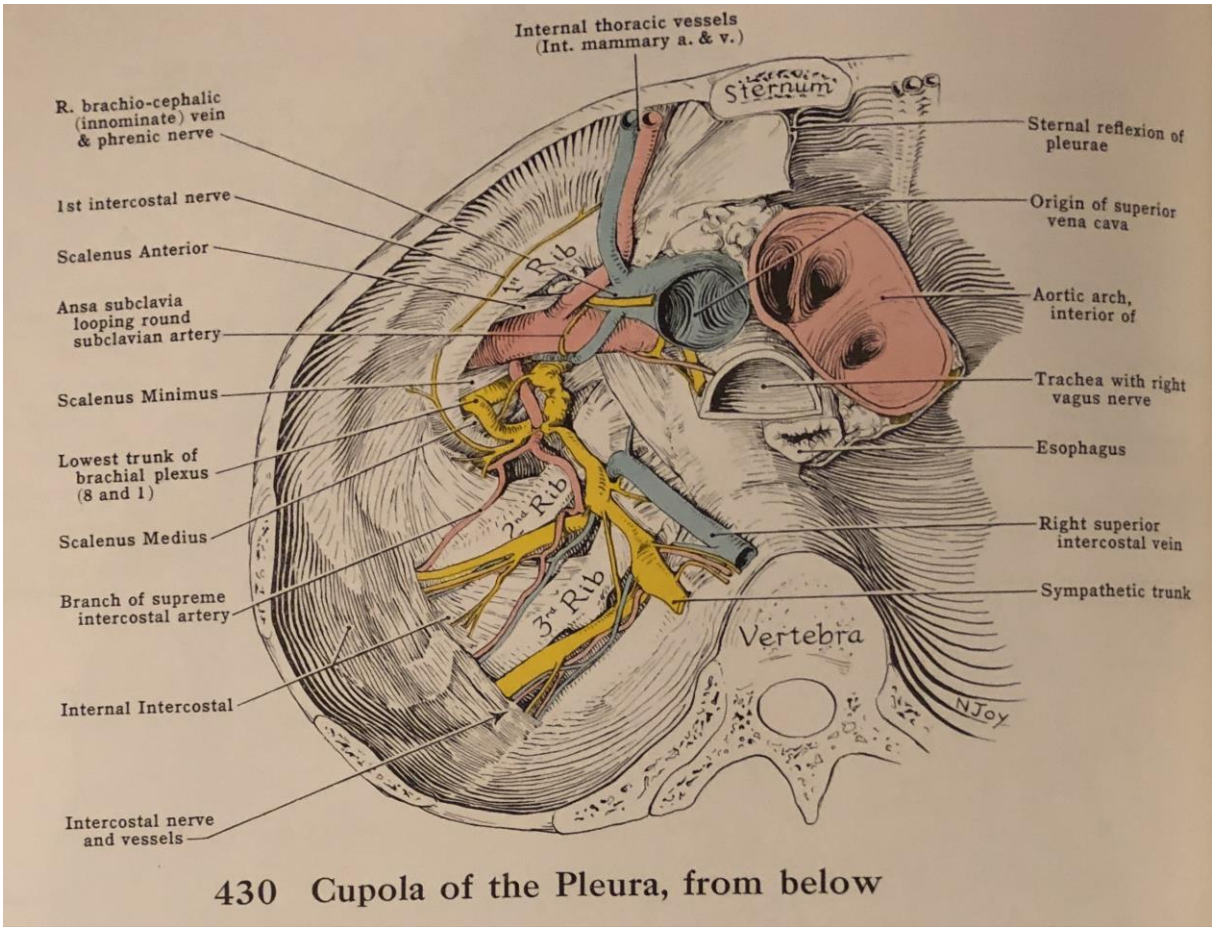

Figure 9, Example of Writing Variety

edition, the systems employed on one page were used consistently on another. This potentially increased the reader's capacity to anticipate the design of the book and could therefore increase the reader's comfort and engagement with the material. Many of these changes reflect an increased technological capacity and an evolving commitment to legibility.

Some changes suggest more philosophical shifts. For example, students are not only thanked in the fourteenth edition, but they are also included as reviewers. This demonstrates a broader understanding of the book's constituency. In fact, this edition not only thanks those listed (including student reviewers) but also acknowledges unprompted lessons learned from

colleagues across the field. The acknowledgements section states, “We would like to thank the hundreds of instructors and students who have over the years communicated via the publisher and directly with the editor their suggestions for how this *Atlas* might be improved” (Agur & Dalley, 2017, p. xi). This edition of *Grant’s Atlas* acknowledges a much larger group of collaborators who produced this text, which may or may not be linked to its philosophical shift away from utilizing symmetry to teach anatomy. Between the fifth and fouteenth editions, the authors of *Grant’s Atlas* welcomed in a larger pool of readers and critics, thereby increasing opportunities for accountability and collectivity. This may have contributed to its philophical restructuring regarding symmetry.

Symmetry in Grant’s Atlas of Anatomy

While the fifth edition of *Grant’s Atlas* explicitly acknowledges the use of symmetry as a learning device, the fourteenth edition makes no mention of this concept. Because research for this paper included the fifth and fourteenth editions only, it is impossible to track the intermediary steps that contributed to this change across multiple editions. However, these texts were produced by different authors, with different readers, in different time periods. Perhaps the cultural moment that allowed Grant to imagine that standardizing the body was effective and useful has passed. It is no longer 1964 and imagining a standardized body that is interchangable from one patient to the next is less likely to be tolerated without critique. As a result, there is no longer a segregated section within a chapter to highlight deviations, abnormalities, or variations in the latest edition. Regardless of the impetus for this change, a pivot away from symmetry as a learning device seems to suggest that the practice is no longer relevent or necessary for a medical student in 2017.

The fourteenth edition does not utilize symmetry to the same degree as the fifth edition. The fifth edition selects a primary side of the body (the right side) and showcases the body from this perspective. At times, only right segments of the body are shown in isolation, such as the hip, the foot, or the shoulder. The fourteenth edition does not select a primary side of the body to demonstrate anatomy and it therefore does not ask the reader to generalize across bilateral sides of the body. Instead, it shows both sides, so a reader need not imagine or extrapolate the body. They can simply look at the page. The fourteenth edition does occasionally privilege the right side of the body, but it also has drastically more variety than earlier editions. Multiple perspectives are often shown and usually there are words or photographs that indicate the particular view featured in a photograph. While one side is still slightly privileged, this choice is contextualized and more often than before, multiple angles are included.

In both editions, symmetry falls away as each atlas moves from more superficial structures into more internal body parts. While the chapters on the back and the limbs utilize symmetry to varying extents, chapters on the thorax, abdomen, and nerves use it sparingly. The purported symmetrical nature of the body only seems to exist in its superficial form. When cross-sections of the body are displayed to show muscles or bones, both bilateral halves of the body are included. However, the organs of the body, like the lungs or the stomach, are not evenly distributed across bilateral halves of the body and as such, are not displayed as halves. The liver is on the right side and not the left. The same is true of the pancreas. Neither edition of the text attempts to represent the innermost structures of the body through symmetrical diagramming. This seems to suggest that the body, at its deepest level, is not symmetrical and the authors seem to acknowledge this across editions. At its core, on the level of the organs, all bodies disrupt

notions of symmetry. However, there seems to be disagreement about the bilateral symmetry of the body on a superficial level.

If symmetry is not consistently used across editions, it suggests that symmetry is not a necessary or even important tool for understanding the human body. In fact, symmetry is a potentially harmful ideal. Symmetry is a purely superficial experience and does not apply to the deeper, internal structures of the body. Moreover, symmetry is too strict an idea for any body to hew to its premise. The fouteenth edition of Grant's Atlas is testimony to its superfluous nature, because it does not utilize symmetry to help readers understand the body. While it is unclear why exactly symmetry disappears from the pages of the atlas, the reasoning may be revealed over time. Future editions will indicate whether the fourteenth edition was a momentary break in a pattern or charting a new course for the text. The fifteenth edition of *Grant's Atlas* is anticipated for distribution in the United States in April 2020.

Connecting Grant's Atlas of Anatomy to Disability Studies

It is never expressly stated within Grant's Atlas that the text moves away from utilizing and assuming symmetry, both for the diagrams on display and for the reader's interpretation. It is therefore important to name this change, as it serves to disrupt the idea of norm created in the fifth edition and offers a new framework for seeing and understanding the human body. The notion of symmetry is itself a social construction, just as concepts of normal or typical are. As Lennard Davis describes, "[t]he idea of a norm is less a condition of human nature than it is a feature of a certain kind of society" (Davis, 1995, p. 65). Disability Studies serves to unravel these societal logics to assert the dignity of more experiences, more embodiments, and more truth. In addition, a Disability Studies perspective inherently challenges assumptions of

symmetry, because ideologies of symmetry typically discount experiences of disability. Disability Studies challenges any ideology that erases disability, because the project of Disability Studies "is to weave disabled people back into the fabric of society, thread by thread, theory by theory" (Linton, 2005).

The harm of symmetry can negatively affect all people, as it is a guideline that no body truly follows. The subject position of the few who stand to benefit from ideologies of symmetry would be called the normate by Rosemarie Garland-Thomson. The normate "is the constructed identity of those who, by way of the bodily configurations and cultural capital… step into a position of authority and wield the power it grants them" (Garland-Thomson, 2017, p. 8). The normate is unmarked by signifiers of disability or any other perceived otherness. This narrow category lends insight into who might adhere to the strictness perscribed by symmetry. The construction of the normate highlights the far greater proportions of people that live outside its boarders, marked by otherness to some degree.

Imagining bodies as symmetrical has the particular capacity to harm and stigmatize disabled people disproportionately, because for some disabled people, asymmetry is directly linked to an experience of disability. For example, amputees live with a single arm or a single leg. People with dystonia or muscle spasms may witness muscles firing from one side more than the other. While Multiple Sclerosis often effects both sides of the body, it can also progress bilaterally along only one side of the body. The same can be true of Cerebral Palsy. Disrupting notions of symmetry can serve all people, but it also has the unique possibility to de-stigmatize visible experiences of asymmetry that result from disability.

By moving away from a generalized ideology and including multiple formats for perceiving the body on a page (diagrams, photographs, and charts), the most recent edition of

Grant's Atlas seems to assert the uniqueness of the body instead of presuming any sort of average or norm. The fourteenth edition of *Grant's Atlas* is more closely aligned with these values than the fifth edition produced in 1962. This most recent edition trains its reader to view the body differently than the viewpoint offered to students in the 1960s. The medical gaze, described by Foucault as the calculating observation justified by an institution to intervene in someone's life based on personal conviction, is given a bit more room to perceive the body in its multiplicity (Foucault, 1976, p. 89). With fewer diagrams, the photographed body becomes the site of information and these bodies are—to an extent—flawed, quirky and asymmetrical. The fourteenth edition gives students a greater chance to build a medical gaze that conceives of multiple experiences and realities, instead of a singular standard for all people.

By generalizing the body, anatomical textbooks erase the individuality of people in service of broader learning and wider conclusions. Removing individuality necessitates erasing narrative from the pages of each text. To this, Frank proposes a practice he calls, "thinking with stories" (Frank, 1997, p. 158). This practice seeks to end the use of a patient's narrative as the *case* and weave it back into epistomological work of the text. Frank explains, "[t]hinking with stories means joining with them, allowing one's own thoughts to adopt the story's immanent logic of causality, its temporality, and its narrative tensions" (Frank, 1997, p. 158). While an anatomical atlas is not by nature a narrative work, many of the issues created through its design might be mitigated through thinking with stories, even just a little.

The fourteenth edition of *Grant's Atlas* employs Frank's practice of thinking with stories more than the fifth edition. If thinking with stories involves retaining personhood and personality throughout the transmission of medical data, then the fourteenth edition makes a clear attempt to hold onto subjectivity. Because this edition includes untouched photographs of actual bodies, the

particularities of each body remains. There are visible wrinkles (Agur & Dalley, 2017, pg. 444). The models have body hair (Agur & Dalley, 2017, pg. 292-293). One model has visible acne (Agur & Dalley, 2017, pg. 65). Still, these bodies are mostly headless, their names are not conveyed, and the reader is given no personal data on the models. The fourteenth edition does not endeavor to include narrative personal information, as it is an atlas and not a textbook. However, through the use of photography, it retains some characteristic that suggest personality and story. The atlas has a long way to go to truly include stories and to include more diverse bodies, such as visibly disabled people, fat people, and more people of color, but its attempts are visible in this most recent edition.

Medical atlases provide valuable insight into how knwoledge about the body is codified and disseminated. *Grant's Atlas*, in particular, offers insight into the various ways symmetry is utilized to frame and perceive the body. The evolution of the atlas, between the fifth and fourteenth editions, seems to suggest that symmetry is ultimately not a very useful concept to describe the body. The use of symmetry upholds norms that are simply untrue, especially past the surface level of the body, and can prove harmful, especially to disabled people. In order to always weave disabled people into society, medical atlases should continue to include more and more diverse bodies with their particularities, unique attributes, and commonplace characteristics.

DISCUSSION

There existed several constraints in the creation and implementation of this research. There are several books that contribute to this research which are now considered artifacts and are therefore kept in museums and maintained in private library holdings. These texts were impossible to access directly. Such books include Dürer's *Four Books on Human Proportion* and Vitruvius's *Ten Books on Architecture*. The researcher is grateful to online sources that provided transcriptions of these texts, such as the Gutenberg Project. It was also quite difficult to access outdated anatomical atlases, as libraries and universities often carry only the most recent editions of a given text. Older versions are typically out of print and can therefore be prohibitively expensive. While the researcher would have liked to compare the first and oldest edition with the fourteenth and newest edition, this was not an option available within the time and financial constraints of the project. It became clear throughout data collection that it would also be useful to consider all editions to chart incremental change. This too was not an option due to time and financial constraints. The editions were selected for their availability and the quantity of editions were selected to match the timeline of the research project.

There are many lingering questions that have gone unanswered through the course of this research that would certainly benefit from futher study. In the fifth edition of *Grant's Atlas*, the right side is featured and not the left. The researcher is unaware of how or why this side was selected and what bias may have contributed to this decision. Perhaps more pressing, it is unknown why the fourteenth edition does not utilize symmetry at all. Future research can and should look at all fourteen editions to track this shift more incrementally and search for the particular moment when symmetry stopped being utilized to represent the human form.

There is still much research needed at the intersection of medical illustration, symmetry, and disability. While this paper considers one application of symmetry through medical textbooks, there are many other popular anatomical texts that warrant examination and analysis, namely *Grey's Anatomy* and *Netter's Atlas*. Further, there is far more detailed work necessary to untangle the intricate web that connects symmetry and disability. While medical textbooks offer one site of this interaction, anatomy books are limited in scope. They are utilized primarily by medical professionals and uphold a medical framework of disability, which can be reductive in its objectivity. Symmetry and disability can be explored through investigations of embodiment and perception, interviews with individuals about their orientation towards symmetry and ableism, and physical investigations to disprove ideologies of symmetry. These are just a few ideas.

In order to unravel the connections between symmetry and disability, a flexible understanding of ableism must be forged. While ableism is a term found in dictionaries and is widely used throughout the field of Disability Studies, there current debate about its definition. The current definition from Merriam Webster explains ableism as "discrimination or prejudice against individuals with disabilities" ("Ableism," n.d.). However, some feel that this definition does not hold people to account for oppressive behavior and violence, like other terms that describe descrimination such as homophobia or racism. Talila "TL" Lewis has proposed a working definition that places ableism in conversation with racism. Lewis (2019) currently defines ableism as,

> A system that places value on people's bodies and minds based on societally constructed ideas of normalcy, intelligence and excellence. These constructed ideas of normalcy, intelligence and excellence are deeply rooted in anti-

Blackness, eugenics and capitalism. This form of systemic oppression leads to people and society determining who is valuable or worthy based on people's appearance and/or their ability to satisfactorily produce, excel & 'behave.'

Importantly, you do not have to be disabled to experience ableism.

Though ableism is found in the very title of this paper and has been a constant consideration throughout the research process, it must be acknowledged that the term itself is in flux and its definition and utility is continually evolving. Further, Lewis's definition acknowledges that racism and ableism are mutually constitutive. This definition proves useful for future analysis of anatomical texts that considers the racism embedded in representation, authorship, and notions of health.

Lastly, this paper would have greatly benefitted from a published work that traces the ideation of symmetry. While Hermann Weyl's *Symmetry* shares mathematical foundations that undergird the concept, it does not explore the genesis of this idea or trace its mapping onto bodies, architecture, and social structure. Symmetry itself seems to be a rather uncontested notion in print. Outside of one's own body and experience, there is little source material to bolster any claim that symmetry is imaginary and this collective imagining produces harm—to everyone and to disabled people more frequently. To mitigate this harm and re-imagine the public in its glorious imperfection, symmetry should be problematized in discussion, in imagery, and certainly in print.

CONCLUSION

Because there are very few scholarly resources that affirm the inherent asymmetry of the human body, this paper is indebted to embodiment. For it is feeling and sensation that drives the conviction that no body is truly symmetrical, despite cultural yearning for human architecture that would be simple, neat, and even. Whether this asymmetry is felt in the length of one's gait or is visibly perceptible to others, it is a fallacy that the human form adheres to such a strict mathematical principle. It is therefore important that the systems that deal with bodies—including health, medicine, sport, art—reflect not codified bodies that adhere to imagined, impossible standards, but bodies of real people. From the analysis derived in this paper, this appears to be the current trend. Symmetry seems to be utilized less frequently in the most recent edition of *Grant's Atlas* and perhaps this is an indication of a cultural shift. Regardless, everyone has much to gain from releasing the notion that symmetry is a metric to understand the human form.

Disability and Disability Studies illuminate the construction of symmetry and frame this idea as a harmful tool that is disproportionately harmful to disabled people. Symmetry is not a useful tool to perceive the body, because it necessarily creates deviations and deviance. Instead, the variety of the human form should be showcased and utilized whenever possible. Technological advances, such as photography, increase this possibility and hopefully future technology continues this trend. It also seems likely that increased accountability, through collective production, contributed to the reframing of the body without the guise of symmetry. Collective practice offers great promise for more accurate and more complicated representation.

Anatomy atlases have the particular privilege of framing and codifying knowledge about the human body. These forums dissemminate knowledge, primarily to medical professionals,

who have the great capacity to translate their knowledge into practice with patient after patient after patient. If these atlases hold more complicated truths, that don't adhere to cultural ideology but instead show the body in its splendid complexity, then those in medicine stand a better chance of treating each individual with dignity and personhood. Further, it would allow disabled and non-disabled doctors to view their bodies with the same paradigm as their patients: asymmetrical, just like everybody else.

BIBLIOGRAPHY

Ableism. (n.d.). Retrieved December 14, 2019, from https://www.merriam-webster.com/dictionary/ableism.

Agur, A. M. R., & Dalley, A. F. (2017). *Grants atlas of anatomy* (14th ed.). Philadelphia, PA: Wolters Kluwer Health.

Course Information. (2019, August 1). Retrieved from https://web.duke.edu/anatomy/information.html.

Crosby, R. W., & Cody, J. (1991). *Max Brödel: the man who put art into medicine*. New York: Springer-Verlag.

Davis, L. J. (1995). *Enforcing normalcy: disability, deafness, and the body.* Brooklyn, NY: Verso.

Dongen, S. V., & Gangestad, S. W. (2011). Human fluctuating asymmetry in relation to health and quality: A meta-analysis. *Evolution and Human Behavior,32*(6), 380-398. doi:10.1016/j.evolhumbehav.2011.03.002

Dürer, A. (1990). *Albrecht Durer: the complete woodcuts*. Bristol, Avon, England: Artline Editions.

Frank, A. W. (1997). *The wounded storyteller: body, illness, and ethics*. Chicago: University of Chicago Press.

Garland-Thomson, R. (2017). *Extraordinary bodies: figuring physical disability in american culture and literature*. New York: Columbia University Press.

Grant, J. C. B. (1962). *Grants atlas of anatomy*. Baltimore, MD: Williams & Wilkins.

Gray, H. (1985). *Gray's anatomy (30th edition)*. Philadelphia, PA: Lea & Febiger.

Gray, H., & Carter, H. V. (2014). *Anatomy: descriptive and surgical*. Charlotte, NC: T&J.

Habib, M. B. (n.d.). MEDS 320: HUMAN CADAVERIC ANATOMY. Retrieved from https://web-app.usc.edu/soc/syllabus/20183/41406.pdf.

History & Archives. (n.d.). Retrieved from https://medicalart.johnshopkins.edu/history-archives/.

Inke, Gabor. (1971). A List of Most Frequently Recommended Medical Textbooks. *Bulletin of the Medical Library Association, 59* (4), 588–598.

Lewis, T. L. (2019, March 5). TL's BLOG. Retrieved from https://www.talilalewis.com/blog.

Linton, S. (2005). What is disability studies. *PMLA: Modern language association, 120* (2), 518-522. Retrieved from https://www.jstor.org/stable/25486177.

Loechel, W. E. (1964). *Medical illustration; a guide for the doctor-author and exhibitor*. Springfield, IL: C.C. Thomas.

Marcus, N. (1997). Storm Readings. In *Storms And Illuminations: 18 Years Of Access Theatre*. Santa Barbara, CA: Emily Publications.

McLarty, MC. (1960). *Illustrating Medicine and Surgery*. Baltimore: Williams and Wilkins.

MD Curriculum: Year One Textbooks. (n.d.). Retrieved from https://libguides.wakehealth.edu/MD_Resources.

Murphy, B. (2019, October 1). These medical specialties have the biggest gender imbalances. Retrieved from https://www.ama-assn.org/residents-students/specialty-profiles/these-medical-specialties-have-biggest-gender-imbalances.

Netter, F. H., & Machado, C. A. G. (2006). *Netters atlas of the human body*. Hauppauge, NY: Barrons.

Panofsky, E. (1955). *The life and art of Albrecht Dürer*. Princeton, NJ: Princeton University Press.

Papadakis, M. A. (2016). *Current medical diagnosis and treatment*. McGraw-Hill Education / Medical.

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). Los Angeles, Calif.: Sage.

Pawlowski, B., Borkowska, B., Nowak, J., Augustyniak, D., & Drulis-Kawa, Z. (2018). Human body symmetry and immune efficacy in healthy adults. *American Journal of Physical Anthropology,167*(2), 207-216. doi:10.1002/ajpa.23617

Penton-Voak, I. S., Jones, B. C., Little, A. C., Baker, S., Tiddeman, B., Burt, D. M., & Perrett, D. I. (2001). Symmetry, sexual dimorphism in facial proportions and male facial attractiveness. *Proceedings of the Royal Society of London. Series B: Biological Sciences, 268* (1476), 1617-1623. doi:10.1098/rspb.2001.1703

Pezas, T. (2016, October 24). Are surgeons still all privileged white men? Retrieved from https://doi.org/10.1136/bmj.i5513.

Phase 1 Recommended Textbooks and Materials. (2019, October 29). Retrieved from https://chicago.medicine.uic.edu/education/md-curriculum/curriculum-by-year/phase-1/m1-recommended-textbooks-and-materials/.

Robinson, C. (1993). *J.C. Boileau Grant: anatomist extraordinary*. Toronto: Associated Medical Services.

Scheib, J. E., Gangestad, S. W., & Thornhill, R. (1999). Facial attractiveness, symmetry and cues of good genes. *Proceedings of the Royal Society of London. Series B: Biological Sciences, 266* (1431), 1913-1917. doi:10.1098/rspb.1999.0866

Siebers, T. (2010). *Disability aesthetics*. Ann Arbor, MI: University of Michigan Press.

The Editors of Encyclopaedia Britannica. (2016, May 4). Polyclitus. Retrieved from https://www.britannica.com/biography/Polyclitus#ref122939.

Tobias, P. V. (1992). J.C. Boileau grant and the changing face of anatomy. *Clinical Anatomy, 5*(5), 409–416. doi: 10.1002/ca.980050508

Tovée, M., Tasker, K., & Benson, P. (2000). Is symmetry a visual cue to attractiveness in the human female body? *Evolution and human behavior, 21* (3), 191-200. doi:10.1016/s1090-5138(00)00040-4

Vesalius, A. (1998). *On the fabric of the human body: a translation of De humani corporis fabrica libri septem*. (W. F. Richardson & J. B. Carman, Trans.). San Francisco, CA: Norman Publishing.

Vitruvius. (2006, December 31). The Project Gutenberg EBook of Ten Books on Architecture. Retrieved from http://www.gutenberg.org/files/20239/20239-h/20239-h.htm.

Walden, M. (2019, October 16). Planes Of Motion - Sagittal Plane, Transverse Plane, Frontal Plane. Retrieved from https://www.teachpe.com/anatomy-physiology/planes-of-movement.

Weyl, H. (2016). *Symmetry*. Princeton, NJ: Princeton University Press.

Zimmer, C. (2013, June 3). Growing Left, Growing Right. *New York Times*. Retrieved from https://www.nytimes.com/2013/06/04/science/growing-left-growing-right-how-a-body-breaks-symmetry.html