UNIVERSITY OF CALIFORNIA SAN DIEGO

The Emergence of Pain Quantification and Visualization in the Computation Culture of Cold War Era United States

A Thesis submitted in partial satisfaction of the requirements for the degree
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Art History, Theory, and Criticism

by

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ABSTRACT OF THE THESIS

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This thesis draws together design history, pain science, and information studies to consider the ways that medical clinicians incorporated quantitative methods and tools from graphic and industrial design and, reciprocally, the ways in which designers used methods and ideas from the biomedical sciences in the US and UK between 1945 and 2015. The project is organized around postwar changes in pain science in clinical medicine and proposes that a measurement, representation, and move toward quantification in clinical pain medicine occurred

in tandem with the turn toward computing in the arts and in graphic design. Subsequent advancements in personal and wearable computing shifted health and wellness personal technologies markets around concepts of "self-health." The project culminates in the emergence of "the quantified self," a concept interpreted in this project to the development of quantitative tools and methods in computing and computer graphics devoted to advancing a neoliberal model of knowledge and experience of the individual's bodily pain.

Introduction

A scenario to consider: Patient Sam wishes to speak with a medical professional about their chronic back pain. They call their primary care provider and make a 15-minute appointment for an examination so that they might receive a diagnosis, referral, and, subsequently, permission from their insurer to see a pain specialist. At the specialist, a nurse asks how bad the pain is on a numeric scale and shows Sam a set of six faces, each minimally illustrated and each expressing a different level of anguish (or lack thereof). After making a selection, Sam is then asked about the details of their pain: is it shooting? Throbbing? Dull? Soon after, the doctor pays Sam a quick visit to evaluate and make recommendations based on the patient's reporting. Sam is given some stretches to do at home and a prescription for the pain, but also told to track their pain on a regular basis using a smartphone application. They are expected to report back to the pain specialist with the data collected in the app to make sure the agreed upon course of treatment is working. After this brief interaction, the doctor leaves, Sam is charged, and a followup appointment is made.

This scenario could be viewed through a plethora of lenses, the most of obvious of which is a biomedical one; we could consider Sam's condition as a set of neurophysical relationships occurring in their body—from the pinched nerve in their lower spine and the pain signals being sent to their brain, to the way their nervous system will react to the stretches and pills. Setting aside for a moment the lengthy history of biomedical science upon which that sort of narrative would be built, let us consider how else we might understand Sam's story. Embedded within the smartphone app that Sam downloads are technologies of representation, quantification, classification, and computation. Their physician's recommendation to self-track has a direct

correlation to the feminist self-health movement of the 1970s, as does Sam's requirement to see one doctor for a referral in order to then see another. The pain scale shown to Sam in the specialist's office is most likely being licensed from a corporation whose founders designed it with data from interviews with pediatric burn patients.

In what follows, I argue that the emergence of pain quantification has its roots primarily in the computation culture of the Cold War era—a critical moment that informs the medical-, scientific-, and consumer-grade pain quantifying and visualizing mechanisms used in the twenty-first century United States. Throughout, I move towards an understanding of how Foucauldian biopower works across scientific research, clinical practice, and industrial development of medical and consumer-grade technologies. Because this work is on the emergence of these technologies during the rise of the self-health movement, focus will be given to the use of technologies around pain measurement through consumer technologies such as smartphone apps and consumer-grade EEG-based systems. After this exploration, it will become apparent that there is a complex and multithreaded project present, not yet taken up by the academy.

The Computational Turn in Design

The post-war years saw major shifts in the American graphic design field for a number of reasons. The emergence of mass-consumer culture during that time has been well documented (Meggs 2012, Poulin 2012, Margolin 2015), but, as Meggs (2012) has noted, increased trade across national borders meant the spread of ideas as well. Together with pre- and post-war migration of Russian constructivists, Italian futurists, German Bauhausians, and Swiss

modernists to America, Canada, and the United Kingdom (Meggs 2012), the spread of a systematic approach to design arrived among a West in the midst of rapid economic expansion.

To wit, we might identify three ways these aesthetic philosophies manifested themselves in Western culture:

Using mathematics in design

Embracing the International System of Typography (often called Swiss Type), grids with precisely rationed proportions, straight lines, and modern typefaces were implemented across formats: from posters to fliers, editorial layouts, and so forth. Adrian Frutiger's Univers typeface (Figure 1), meticulously constructed by the Swiss designer to include 21 variations, all designed in proportion to one another, each named with a number (e.g. Per Meggs (377): "The normal or regular weight with the proper black-and-white relationships for book setting is called Univers 55, and the family ranges from Univers 39 (light/extra condensed) to Univers 83 (expanded/ extrabold)," etc.), was released in 1954. Helvetica arrived soon after in 1961. Alumni from the Ulm School of Design brought with them Max Bill's art concret approach, an aesthetic that preached clarity over all, and encouraged the use of arithmetic in arrangement (Meggs 2012).

The use of iconography in data-driven design

In the early part of the twentieth century, Otto Neurath had been working in Europe to develop the International System of Typographic Picture Education, or Isotype (Figure 2), as a sort of "de-babelization" (Neurath 1936, 13). While Neurath wished to keep the design of Isotype icons and graphic maps restricted to only those trained in the process, his mentee Rudolph Modley wanted to encourage its use by virtually anyone. This disagreement caused a

falling out between Modley and Neurath, but the former came to the United States in 1930 and started Pictorial Statistics Incorporated, a firm dedicated to the sale and distribution of Isotype-like iconography (Maloney). One might see the familiar wood-cut aesthetic of Isotype and its derivatives in the Container Corporation of America's 1953 World Geographic Atlas, a 368-page work by Herbert Bayer, a Bauhaus designer who left Germany after the Nazis included his work in their 1937 "Degenerate Art Exhibition". CCA founder and CEO, Walter Paepcke, funded the effort as part of his "Great Ideas" campaign. The Atlas is an early and exemplary artifact from the period when "information design" became canonized in Western culture; previously, it had been used primarily for economic and political purposes (Heller).

Taking a more systematic approach to the design process

According to design theorist and historian Victor Margolin (2002), Herbert Simon's 1988 essay, "The Science of Design: Creating the Artificial" (1969), "seeks to legitimize design as a science by reducing the role of intuitive judgment in the design process as much as possible" (234). Simon's efforts to create a science of design began in the 1960s when he gave a series of lectures at MIT during which he argued for designs enacted less on intuition than on computation. Josef Albers, another Bauhausler, first published Interaction of Color in 1963. He perhaps combined both intuition and computation with this compendium of 150 silkscreens demonstrating complex color theory. Other examples of attempting a scientific approach to design includes the Italian modernist, Massimo Vignielli, who suggested that all of the designers at his firm, Unimark (the largest design firm in the world from 1965 to 1979), wear lab coats (Poyner 2009; Figure 3). And perhaps most the most famous of designer-scientists, Buckminster Fuller went so far as to declare a "World Design Science Decade" from 1965 to 1975. His vision

was to encourage a designed world that only used the minimum amount of natural resources for the fewest tools necessary to exist (Fuller 1965). The work of Gyorgy Kepes, a member in the latter years of the Dessau Bauhaus, proves critical here as well. Kepes, a figure influential in the intersection of art, design, and engineering, initiated the Center for Advanced Studies at MIT in 1947 after having taught at Chicago's New Bauhaus (now the Illinois Institute of Technology Institute of Design). From 1944 to 1972, he wrote and edited a number of volumes (including his 1965–66 Vision + Value Series) which exhibited both art and essays at the intersections of aesthetics, language, structure, and vision.

We will see how this turn in design may have manifested in the visualizations associated with and used by clinical pain practitioners and patients. First, it is important to introduce the ways in which pain is "visualized" in these contexts.

Pain Visualization

In considering how pain might be "seen" across consumer and biomedical contexts, there are three approaches we might take. The first, a review of the visual elements used in personal pain management smartphone and internet-based applications, can best be governed by principles of data visualization and information design—both fields that combine information and design studies. Secondly, the ways in which the body is abstracted for pain tracking and measurement—that is, illustrated representations of faces and torsos used to represent reactions to pain (in the case of the widely used Wong-Baker FACES Scale)—requires a consideration of the delineations of "steps" of pain and how they might be expressed on the normative face or body. Finally, a review of the digital representations of the body made possible by machinic

measurement—in the below case, electroencephalograph (EEG)—leans heavily on theories of the perceived objectivity provided by imagery in scientific research.

Data Visualization

Per Lalloo, et al., in a 2015 article published in the *Clinical Journal of Pain*, there existed between May and June of 2014, two hundred and seventy-nine smartphone applications (or, apps) across the four major platforms (Android, iOS, Windows, and Blackberry; see Figures 4–6 for examples) used for "self-management" of pain, including those with features to "engage in pain education (45.9%), self-monitoring (19%), social support (3.6%), and goal-setting (0.72%)." Neither this article, nor any of those cited by the researchers, include a review of the visual measurement elements of the apps—graphical devices such as color, scale, or position, used to represent intensity of pain (some articles, such as Reynoldson, et al., 2014, include evaluations of the colors or fonts used in the app's user interface). While a full study of the top pain-management app in this context is well beyond the scope of this paper, there are a number of approaches that could inform an understanding of the graphical implements.

From a historical perspective, the emergence of the information design (used here interchangeably with data visualization) practice—that is, the use of maps, charts, illustrations, graphs, and other graphic-heavy visual elements to convey a data-based message—is often traced back to the work of William Playfair in the late eighteenth century. His 1787 *Commercial and Political Atlas* (2005) featured a plethora of graphs and charts that were not geographic, but economic—a true novelty at the time. In the context of public health, Dr John Snow's 1849 paper, *On the Mode of Communication of Cholera*, was a poorly received argument against the miasma theory of disease communication (that is, that diseases were spread via the air and not

direct contact or contaminated water). In 1854, he published a map of London with one small rectangle placed on each block for every case of cholera discovered on that block. By visualizing the data he had already collected, he was able to convince the city administrators that the source of the cholera was a contaminated water pump, leading to its closure and the eventual dissipation of the disease outbreak (Tufte 2001).

The examples of Playfair and Snow are used heavily by perhaps the most prolific voice on data visualization in the late twentieth and early twenty-first century, Edward Tufte. An economist and amateur sculptor at Yale University, Tufte has built up a "how-to" empire of books, consulting jobs, workshops, and essays all revolving around what makes "good" or "useful" data visualizations. As I have argued elsewhere (Schaffzin 2013), Tufte's work has strongly influenced the field of information design by arguing that following his principles helps the designer produce objectively true visualizations, and so evaluating the graphics in pain-management apps against these principles[1] may be a logical approach.

Nowhere in Tufte's work does he reference another important figure in the history of information design, Otto Neurath. Neurath, whose work as director of various local museums in Leipzig and Vienna was interrupted with the eruption of World War II, at which point he fled to London (Lupton 1986). A founding member of the Vienna Circle's logical positive movement, Neurath was particularly interested in how to express statistical knowledge through verbal language and the rules which accompany it. In turn, he developed a system of pictograms,

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[1] In his fourth and most recent volume, *Beautiful Evidence* (2006), Tufte presents a list of six principles: Comparisons; Causality, Mechanism, Structure, Explanation; Multi- variate Analysis; Integration of Evidence; Documentation; and Content Counts Most of All.

designed and arranged (sometimes alongside written language) with a logic he felt unattainable through words alone. He eventually titled this system the International System Of TYpographic Picture education, or Isotype (Lupton; Neurath 1936, 12–15).

Perusing the Isotype archives at the University of Reading outside London, one might recognize Isotype's woodcut aesthetic, designed by Neurath's colleague, Gerd Arntz—variations on the flat, often monochrome icons for *mann* or *frau* can be found on most restroom signage today (see Figure 3). Despite encouragement from his disciple, Rudolph Motley, Neurath resisted allowing Isotype to see widespread implementation without his supervision. This was, in fact, by design. As Robin Kinross writes, "Neurath developed the notion of transformer (it was 'Transformator' in German) to describe the process of analysing, selecting, ordering, and then *making visual* [emphasis his] some information, data, ideas, implications" (Neurath and Kinross 2009, 6). The transformer (it was often Neurath's wife, Marie) met with clients and other stakeholders on each project and ensured that the correct meaning was being instilled into each resultant chart or map.

The history of Isotype might then act as a counter to Tufte's modernist approach to information design. Despite Neurath's association with the positivist movement, as he sought to implement Isotype as a universal language, he recognized the perspectival nature of the medium. Returning to our smartphone apps—replete with bar, line, and iconographic charts using colors and lines representing intensity of pain on numerical scales—it is critical to consider the design and authorship of the applications and their respective interfaces. Per Lalloo, et al., of the 279 evaluated programs, "only 8.2% of apps included a health care professional in their development, not a single app provided a theoretical rationale, and only 1 app underwent scientific

evaluation" (557). The scant results for a search for publications authored by the designers or developers of the applications include only justification that the use of the app—not the actual decisions made in its design and development—is valuable to pain-management programs.

Although not in the context of *pain* visualization, sociologist Helen Kennedy and her collaborators have written extensively on both the implications of data visualization authorship and the subjectivity of the viewer of the design. In a 2016 article (Kennedy, Hill, Allen, Kirk), the authors argue that data visualization is the primary means through which non-experts gain access to data. Using a number of factors that affect engagement with data as a framing mechanism for qualitative research with users of data visualizations, they argue that their "findings have implications for how effectiveness is conceived and defined in relation to data visualizations and how this varies depending on how, by whom, where and for what purpose visualizations are encountered." Further, in a different paper, Kennedy, Hill, Aiello, and Allen (2016) use a "social semiotic analysis" to discuss how conventions in data visualization—clean layouts (about which they credit Tufte as being a major influential voice), shapes and lines, two-dimensionality, revealing data sources—work to make the data represented within seem "objective, that is, transparent and factual." This article is followed up by Kennedy and Hill (2016) who argue that the urge among researchers to visualize data is a complex entanglement of factors, including an intriguing look at "datafication and the neoliberalization of the university." Finally, Kennedy and Hill (2017) collaborate once again to contribute to sociology of data literature by considering the "feeling of numbers" and how important that concept is when seeking to understand data-driven design. Their argument surrounds the emotions involved in

seeing *and understanding* data visualizations and how the perceived objectivity of the form goes hand in hand with rationality.

Looking at pain-measurement visualizations through both a history and theory, then, would provide a strong foundation upon which to understand the sorts of translations and transformations taken on by both the author and viewer of the data-turned-graphical. Concurrently, it might also raise questions regarding who counts as author (the designer/ developer of the application or the patient who inputs the data) or viewer (the user or the medical professional who must interpret pain measurements to decide on course of treatment). These questions touch upon our relationship to our technology—something that will be covered in a future section. For now, however, it is important to consider those mechanisms used to measure and locate pain that are not as abstract as a yellow or green square on a calendar or a red line on a graph.

Referential Graphics

The Wong-Baker Faces Scale (branded "FACES" in capital letters by the organization which now owns and licenses the rights to its use) was researched and designed by Connie Baker and Donna Wong, who met at the Hillcrest Medical Center in Tulsa, Oklahoma in the early 1980s. Both concerned about talking about pain with children, the pair worked together, interviewing pediatric burn patients who were unable to use existing pain scales to communicate how they felt:

> Young children had considerable difficulty using any scale with a number concept, ranking items such as cylinders with varying amounts of liquid in them, or any tools with unfamiliar words. Some children did not know colors well enough to create their own

> color scale and often had biases for various colors. When they did create a color scale, the color choices were not consistent with their peers, making the use of color difficult to replicate on a larger scale. (Baker, n.d.)

Wong and Baker asked the children to illustrate how they felt using drawings of faces, emphasizing that they hoped the patients would use their own experiences as inspiration for how each step along a scale of six faces would appear. Eventually, the pair hired an illustrator to standardize the scales in the familiar six-faced sketch present in physicians' offices and triage rooms across the globe.

The Wong-Baker scale is by no means the only option for visual scales that ask the patient to consider the face with which they most closely identify. The Oucher scale ("How to use the Oucher"), for instance, uses six photographs of children's faces on a 0–10 scale (Wong and Baker specifically note that they wanted to keep the "cartoon-type" illustrations of the faces as abstract as possible, so as to "avoid gender, age, and racial biases" (Baker, n.d.)). The developers of the Face Pain Scale (FPS; Bieri, et al., 1990), criticize Wong-Baker for including a smiling face at the beginning of the scale, thus suggesting that a pain-free experience is inherently happy. The FPS features seven faces that are more representative of a human head—egg-shaped, rather than perfect circles, with inclusion of brow furrows; even though the scale was developed with children in mind, the head appears much more adult. Just over ten years after the development of FPS, it was revised (as FPS-R) by Hicks, et al., to include only six faces in order to build a commensurability between other scales.

The faces on these scales are not, of course, the value recorded by interviewers or caretakers—rather, the faces are reference points for caretakers to use when inquiring as to the

level of pain in their patients; a numerical value is still recorded in the patient's records. Wong and Baker felt that 0 through 5 (as there are six faces) was possibly incommensurate with the previously established 0 through 10 scales, so they assigned each face two values (0, 1-2, 3-4, 5-6, 7-8, 9-10). FPS-R researchers, seeking a "common metric" that could be used more widely, noted that "self-report pain intensity measures designed for adults commonly have finer, more numerous division" (Hicks et al. 2001, 173), offering that some adult-grade scales use 0–100. This, in turn, raises questions around the delineation of the thresholds between values corresponding to severity of pain, especially as these pediatric-minded scales have proliferated into adult care situations.

Quantitative classification, especially in the biomedical and health context, will be covered further in this paper, but it is important here to make a connection between the face-based pain scales discussed in this subsection and the types of applications referenced in the previous one. Specifically, the information design and data visualization referenced in my discussion of pain-management apps is collected through self-reporting done by the user of the application. Some applications use a color scale, some use faces, and some ask for a number between, say, 1–5 or 1–100. Just as with the face scales, no matter the mechanism, a numerical value is stored in the application's database (even in the case of color scales that never undergo mathematical calculations, color systems on computers and smartphones are based on hexadecimal values for levels of red, green, and blue). Thus, at the root of both self-reporting apps and interviews conducted in the context of medical treatment, numbers must be stored if calculations are to be made, graphs to be designed. As we will see in the next subsection, while efforts to move beyond subjective self-reporting and into a more "visible" pain in the body

abstract further from numerical values on the interface level (that is, what the caretaker or patient sees on the screen), computation and quantification are still critical elements of the practice.

Sensor-generated Data Visualization

Billed by its founders as a "powerful solution software which will quickly analyze neuropathic electrical activity and translate that into an objective accurate pain score in real time" (medcitynews), PainQX is an early-stage startup based on the analysis of brain activity quantification. The system uses electroencephalogram (EEG) data, technology which measures electromagnetic activity being broadcast from your brain. Until 2010, EEG research was primarily relegated to the scientific or medical laboratory, but advances in miniaturization and consumer-level computing power led to the widespread development and sale of EEGs that transmit brain activity data to your smartphone or home computer. PainQX, which had raised $1.3MM as of 2015 and projected $285MM in sales by 2020, relies on consumer-level EEG data uploaded to its servers and interpreted using proprietary algorithms to indicate levels of pain ("PainQx Executive Summary"). The company cites a number of studies, published between 2011 and 2017 (Prichep et al., 2011; Malver et al., 2014; Morton, Sandu, and Jones, 2016; Pinheiro et al., 2016; Prichep et al., 2017) that point to EEG data analysis as a scientifically valid method to evaluate pain in the patient.

EEG systems track the amplitude of electromagnetic waves being emitted through a subject's skull as brain activity levels fluctuate. Numerical values corresponding to different tracking points on the skull are stored over time to indicate more or less activity. Researchers then use heat maps of each patient's brain (images using color to represent brain activity superimposed on a normative brain map called the Probabilistic MRI Atlas (Prichep et al. 2011))

before, during, and after pain is inflicted on the subject. Using this data, the regions where pain is most likely expressed by brain activity can then be used to determine a normative baseline in new patients (Prichep et al. 2011).

There are a number of ways to relate the use of EEGs in pain-measurement to our current study, as it is heavily reliant on quantification and increasingly being considered valid for use in consumer, laboratory, and medical contexts. However, as historians of science Loraine Daston and Peter Galison demonstrate in their STS staple, *Objectivity* (2010), work done on and about the electroencephalogram immediately after WWII (a period that is, as I will soon demonstrate, critical to this project) ushered in a promising but complex debate within science surrounding the field's inherent objectivity, or lack thereof.

In 1941, Frederic A. Gibbs and Erna L. Gibbs published their *Atlas of Electroencephalography*, a 221 page compendium of brain wave data. An announcement about the release of the book in the *Journal of the American Medical Association* (1941) notes, "The medical reader who opens a book and realizes that a long hidden mystery of the human body stands revealed experiences the sort of thrill which must have chilled the spines of Columbus and Magellan when they first looked on unexplored lands." Much like Neurath required contextual interpretation to be done during the development of Isotype pictograms, the Gibbses emphasize that the reader of their *Atlas* use it as a supplement to that reader's own expertise—as Daston and Galison quote, "'so that he can arrive at diagnoses from subjective criteria'" (2010, 321).

Daston and Galison go on to demonstrate that the Gibbses were perhaps a signpost—in Daston and Galison's words, "an epistemic footprint" (324)—of a mid-century acceptance of subjectivity in medical imagery, one that had been rejected during the previous decades' medical-

machinic revolution (during which we see the introduction and proliferation of a multitude of other technologies such as the x-ray). However, the language surrounding both market-based EEGs (e.g., PainQx) and scholarly research on the use of EEG in pain measurement 70 years after the publication of the Gibbses' *Atlas* is decidedly counter to the aforementioned "epistemic footprint": Saab (2013) cites Prichep, et al. (2011), arguing that "quantitative EEG may provide a portable, objective and quick screening method for a pain biomarker in a clinical setting." PainQx's homepage declares that the product "Confirms the actual level of pain in chronic pain patients."

To be sure, the Gibbses were not alone in their suggestion that EEG data be taken as interpretable and subjective. Per Daston and Galison, "As an encephalographic atlas from 1962 strikingly put it, 'The encephalogram remains more of an empirical art than an exact science'" (328). This quote from Hallowell Davis's introduction to William F. Caveness's *Atlas of Electroencephalography in the Developing Monkey Macaca mulatto* is particularly notable for a number of reasons. Firstly, it indicates that the Gibbses may have been hedging against the EEG's technological imprecision—something that has been mitigated over the three quarters of a century since they published their work (Daston and Galison, it should be noted, do not specifically address the resolution, fidelity, or accuracy of the EEG in their review, though they do suggest that the Gibbses' *Atlas* was not an aberration in the couple's preferred scientific ontology). Secondly, however, the date of publication of Davis's words is important: squarely within the emerging computation culture of the 1950s and 1960s. Perhaps, then, the caveat can be seen as a wish *for* an EEG that can be used as exact science.

Daston and Galison go on to explain that "this frank admission of the craft nature of encephalogram reading dovetails—and may have absorbed—a debate over judgment and objectivity in clinical medicine" (329) and their further exploration of this debate is something I will not delve into here. I am suggesting, however, that the EEG is a critical target of interrogation if we are to understand the emergence of pain quantification and measurement: its use as a tool to translate electromagnetic waves to numerical values and into visual heat maps speaks to a reliance of quantification and visualization for an "objective" and "accurate" measurement of pain, but its history may also help usher us from one generation of scientific ontology and technology (and the relationship between the two) into another.

Regardless, we might see a spectrum of pain visualization and imaging techniques: from charts and graphs that abstract subjective self-reporting pain measurements through colors and lines, to facial representation meant to guide a patient through the expression of pain on a specifically delineated scale, and onto scientific imaging techniques that seek to remove self-reporting altogether in the name of objectivity. The next question to address, then, is what *is* being measured and how has our understanding of what "it" is changed over time. In the following section, I will provide a brief history of some critical moments in the history of pain science, noting why those moments are important for our current study.

History of Pain Science

While an extensive review of pain science literature is neither within the scope of this project nor terribly valuable for the history at hand, it is critical to understand major shifts in the way pain research and discourse was framed over the past 150 years—that period being rich in developments within anthropometric and quantification technologies. In this section, I will trace

a history of pain science using the work of three different types of scholars: an historian, a psychoanalyst, and a medical doctor. Each will reveal an important thread in pain science history to be considered as this project unfolds.

A Traditional History of Pain

Roselyne Rey's 1995 *The History of Pain* is a traditional STS text—in the vein of Ludwick Fleck's *Genesis and Development of a Scientific Fact* (1935)—in that it tracks a history of pain experimentation in order to understand what is meant by the term "pain" itself. The result is an extremely technical text, described by the author as "dedicated to discovering the ways in which physicians, physiologists, and neurologists have throughout the ages attempted to understand the practical mechanisms of pain and to the appropriate remedies for it" (3). The work is organized temporaly: chapters delineate traditional historical periods from antiquity through the middle ages, classical age, enlightenment, the nineteenth century, and into the first half of the twentieth century. Ironically, as elucidated by J. Cambier in an addendum entitled "A Modern View: Pain Today", it was in the thirty years prior to the book's French publication in 1993 (and after the final year of interrogation by the author) that medicine's understanding of the science behind pain accelerated exponentially. Perhaps Rey would have written an update to her text had she not passed away from cancer in 1995, three years prior to the book's American publication (notably, her untimely death leaves the reader considering what Rey's own experience with pain and medicine was as she wrote).

Rey makes no attempt to argue that pain is simple. Instead, she recognizes the extraordinarily complex nature of the subject at hand, acknowledging early on that there are many ways that the "pain" sensation in a body can be understood. "In analysing pain's various

processes," she writes, "the problem remains to reconstruct all the multiple interactions involved, its duration, its repetitions, the influence of past experiences, as well as affectivity and sensitivity factors, automatic reflexes and deliberate reactions" (7). Still, while her work is narrowly focused on the history of clinic- and laboratory-based investigations on how pain works in the body, a number of key themes and practical shifts stand out as relevant to our current project.

In particular, Rey traces the emergence of a nosological approach to pain through a newly secularized Europe in the eighteenth century. This, in turn, provides an entry point to pain science for the Foucauldian medical gaze: the search for the pain-causing lesion, rather than a purely symptomological approach. In the following chapter, Rey moves her readers into the nineteenth century and discourse surrounding the "utility" of pain. She highlights the importance of publishing and journals in the advancement of pain-related discoveries around this time, but emphasizes that "there are no attempts undertaken whatsoever to bring all these facts together" (135). This seems to have slowed the spread of the notion that pain was not "useless"—a belief that was gradually relinquished towards the second half of the century. Darwin is referenced often in discussion of pain utility, as many researchers argue (though in varying ways) that pain contributes significantly to the ability for a species to survive and to the ways it evolves. Foucault's work, again, is provided an opportunity to enter the discussion, as the biopolitical implications of whether pain has "value" to a population or governing body become relevant.

Rey's focus in her chapter on the first half of the twentieth century is on communication and measurement strategies—obviously highly relevant to the study at hand. While the technical nature of the descriptions of the research that she cites makes much of this chapter inaccessible

to those lacking clinical training, there are important discussions surrounding the delineation between physical and psychological pain, evolutionary theory and pain, the value of pain avoidance, and, once again, pain utility. In her conclusion, Rey observes that "the time lapse between technical progress and the proposed treatments seem[s] striking…The history of pain-relieving practices reveals that it has often been governed by different rhythms and logic" (328). Some of the questions raised by Rey in her introduction regarding the ambiguous nature of medical pain studies are never resolved and the author readily acknowledges that. She closes by placing much value in the experiences of the pained:

> Pain, because it is such an extreme experience, seems to call into question the traditional roles allocated to the physician and the patient; it may only be surmounted, in each case, by reappropriating—or by overcoming—one's status as an experimental subject, at the risk of one's life. (329)

What Rey argues here (again, one wonders how much these words were affected by the pain she was experiencing at the time) is a critical element to the current project, one that considers the inherent biopolitical implications of both clinically-led and self-tracking experimentation for the sake of "managing" one's pain.

A Psychoanalytic History of Pain

The full title of Andrew Hodgkiss's (2000) *From Lesion to Metaphor: Chronic pain in British, French and German medical writings, 1800-1914*, while not necessarily misleading, is perhaps a bit encompassing. As the portrait of Sigmund Freud on the cover (alongside Bichat and Wittgenstein, though the latter—whose work falls outside the time period in question—is mentioned only once throughout) indicates, the author, a Lacanian psychoanalyst himself, relies

heavily on noted changes in the relationship between pain without observed lesion and the resultant psychological diagnoses in the patient. “This book,” he writes in the introduction, “is the first to highlight the unique challenge that leisionless pain represented to clinical method after 1800” (3).

Much like Rey, Hodgkiss relies on Foucault’s concept of the medical gaze to illustrate the importance of the presence of a lesion. Whereas Rey only used psychological effects of pain to highlight a focus on utility (i.e., physical pain as a necessary protective reflex to psychological trauma (1995, 218)), Hodgkiss narrows in on the ways in which felt pain was understood to affect *and* be affected by the psychological. He does so in order to address “a cursory historical argument”—a history of lesionless pain as imaginary, “end[ing] in the early 1960s with the rediscovery of the forgotten insight that pain may be an emotion as much as a sensation, and thus lack an object without being unreal, feigned or imagined” (3). His argument, then, is that this insight was present throughout the nineteenth and into the early twentieth century.

Most relevant to our study, Hodgkiss further reveals a possible link between the ways in which lesion-less pain was diagnosed and a modernist need to prove the existence of pain through objective measurement. “By the 1880s the clinical examination of the pain patient had a further new dimension. The language they used to describe their pain had come under scrutiny and was seen as an important sign that could be used to distinguish between neurosis and insanity” (182). That is, patients would be seen as mentally unstable for describing pain without a visible lesion. He goes on to explain that, throughout the second half of the nineteenth century, this type of pain “was characterized as an hallucination, an illusion, a delusion, depressed mood or disordered cenesthesis” (183).

It would be prudent here to address the scope of my project in regards to psychosomatic versus physical pain, especially as Hodgkiss highlights efforts to do so on the part of physicians and psychologists in the nineteenth century. Questions of classification and diagnosis will be addressed in a later section, but I would like to draw a line from the previous section on pain visualization to this question in order to demonstrate the importance of thresholds in this discussion. If we return to to our opening scenario and Sam's visit to the pain specialist, a multitude of binary decisions—pain worthy of a call to the primary care provider, worthy of being granted an appointment there, worthy of a referral, and so on—had to be made along the way. Sam, however, benefits from an early twenty-first century shift in pain medicine—one willing to accept pain as a subjective condition.

Subjective Pain and its Post War History

Both Rey and Hodgkiss end their histories before the end of World War II, so neither have the opportunity to reference the work of Harry K. Beecher, a Boston-based physician who spent time in the Army working under his academic and professional mentor, Edward Churchill. Beecher, who is most widely known for his work on the placebo effect, is the author of *Measurement of Subjective Response* (1959), is a 106-year history of the "quantative work on the effectiveness of drugs" on pain (3). Beecher's background as a medical doctor and researcher is made more evident by a perusal through the index of the book: unlike Rey and Hodgkiss, there are no mentions of Freud or Wittgenstein (Foucault's *Birth of the Clinic* was not published until 1963, but one can imagine that Beecher would not necessarily be looking to include it as a reference had *Measurement* been written five or ten years later). Instead, Beecher's work traces

the scientific findings regarding how pain is measured in order to make an argument about how medicine should be practiced—not simply to understand how it was.

That Beecher emphasizes the patient's subjective experience is not surprising when we consider the "epistemic footprint" left by Frederic and Erna Gibbs with the publication of their *Atlas of Electroencephalography* 18 years earlier. His reasons for doing so perhaps enlighten us to a question raised by the discussion of the Gibbses, above: how to introduce subjectivity to the seemingly objective field of scientific measurement. "There are two principal reasons why a quantitative study of the effects of drugs on subjective responses has seemed worth the considerable effort it has involved," he writes (vii). The first is related to the utility of these studies to future drug research. The second "has to do with fact, eliciting dependable fact in an area traditionally clouded by folklore and sometimes dominated by opinions" (vii).

We have already established, via Rey and Hodgkiss that visible lesions were necessary for a physician to consider a patient's pain to be real. In the case of Hodgkiss, in fact, if that lesion is *not* present, then the patient was considered to have been suffering from a psychological condition. Beecher, however, ushers us into the post-War era by arguing that the pain exists if it can be *measured* (even via the subjective experiences of the patient). In his conclusion to Part I ("The Measurement of Pain"), Beecher indicates that this measurement-equals-existence mentality is not unique to his lab or even pain studies in general:

> Quantitative work with pain is possible and rewarding. Experience in this area has already served as a prototype to guide work with other subjective responses. Quantitative study of the psychological effects of drugs is an urgent need; such work is properly a part

> of pharmacology…Successful pursuit of studies in this field is basic to the sound growth of the behavioral studies. (189)

Despite his clinical vocabulary and sterile tone, Beecher's work extends beyond the influence on clinical drug trials and pain measurement. In fact, his research with soldiers returning from war, along with the work of physician John Bonica, led to pain care as a specialization in the medical field (Wailoo 2014, 34). In the next section, I will delve further into how care for veteran pain became a controversial topic—a fulcrum upon which a larger political and cultural discourse over pain care would be enacted.

Culture of Pain

Pain has been, to put it mildly, a rather pervasive topic throughout early twenty-first century culture. We see it used as a reason for commerce (over the counter pain treatments, ergonomic computer equipment, therapeutic mattresses), for the design of everyday objects (cars, chairs, stovetops), for surveillance (airport body scanners, security cameras, bag inspections at concerts), and so on. Narrowing in, then, on a conception of pain in culture that provides entry to this project's focus (that is, quantified and visualized pain in a computational cultural context) becomes a task of jettisoning those accounts of pain that do not give us direct access to our goal. In that vein, I have set aside works that focus solely on oral or written language (Lascaratou 2007; Biro 2010), or on the painted or illustrated body in pain (Bending 2000; Bella and Elkins 2012), as well as those that ask questions that are more philosophical than cultural (Cohen et al. 2012).

While Elaine Scarry's 1985 work, *The Body in Pain*, shades quite a bit into this third category, I still see it as a valuable resource. Scarry's work, a pillar of pain studies, introduces the

concept of the torturer, seeking to extract out of the tortured an expression of pain. As I have argued elsewhere (Schaffzin 2018, forthcoming), especially in the case of the translations that occur in, for instance, a data visualization, the designers of pain measurement visualizations can be likened to these torturers, as they turn a feeling or condition into something seen or heard, make it real, and take advantage of its apparent state. She writes:

> If the felt-attributes of pain are (through one means of verbal objectification or another) lifted into the visible world, and if the referent for these now objectified attributes is understood to be the human body, then the sentient fact of the person's suffering will become knowable to the second person. (13)

These torturers translate the intangible into the tangible, forcing its reconstruction in a purely visible form, giving us reason to doubt when a visualization may not adequately represent, to treat when a threshold is misplaced.

Turning, however, to a more literal account of how pain is coopted in culture to exercise power, Keith Wailoo's *Pain: A Political History* (2015) traces the legislative and judicial efforts to regulate and make available pain treatments from the end of World War II to the middle of the Obama era, just after the passing of the Affordable Care Act. Along the way, pain is defined and redefined by various administrations who wish to implement their own ideologically driven policies, primarily through the Social Security Administration, Medicare Act, and Veterans Administration (VA). "The book also advances a strong claim," writes Wailoo: "that the complex interaction between liberalism and conservatism can be better understood by considering where politicians, lawyers, scientists, sociologists, and sufferers stand on this question of pain, compassion, government, and relief" (4).

Though he acknowledges that many politicians were exceptions to the rule, Wailoo ties late twentieth-century liberals to a message of "compassion", and conservatives to the argument that not only is this compassion falsified, but so is the pain being treated thanks to the policies enacted by liberals. The idea that those seeking help from the government are "faking it" is built upon a longstanding belief that pain, per eighteenth century conservative, Edmund Burke, is "'capable of producing … a sort of tranquillity tinged with terror; which, as it belongs to self-preservation, is one of the strongest of all passions'" (11) (we see here, as well, shades of the Darwinian approach taken by many of Rey's objects of inquiry). Wailoo's historical approach to the politics governing pain relief, however, allows him to show that both sides' reaction to pain has had to cope with changes in what he calls "the face of pain" (8). He begins at the end of World War II due to the fact that, as he writes, "The cost, complexity, and stakes of pain and disability assessment, which had always been large for government, grew exponentially in the post–World War II years" (17). Citing Beecher's work, Wailoo's focus here continues to highlight the importance of the priority given to Cold War era United States in this project.

If we think of Rey's chronology of pain science as introducing the concept that conditions understood to cause pain in a patient have changed over time, then Wailoo provides not only a continuation from Rey's World War II end-point, but also an indication of what this change looks like from a political viewpoint:

> New maladies and complaints, like fibromyalgia and even 'fetal pain,' rounded out the American pain profile by the late twentieth century, raising new questions about false and true pain and making pain management all along the life course—from birth to death—into a fraught political exercise." (9)

Here, Wailoo previews an important theme in his book: generational shifts in what we were willing to acknowledge as painful. Throughout the Korean and Vietnam Wars, VA claims skyrocketed when pain care became a priority; in 2015, cancer centers are heavily focused on pain treatment. Neither of these were the case at the turn of the century.

However, even as scientists gained and proliferated knowledge on the causes and conditions of pain, per Wailoo, "it has been the courts…that have settled questions about the validity of chronic pain" (12). In fact, as the Regan administration came to office at the beginning of the second to last decade of the century, its members tried to build a litmus test of sorts for what being in pain meant, "To 'change back the definition of disability so that it would rest solely on medical grounds and would not take into account vague …factors, which are so difficult to determine in a consistent manner'" (99). What, then, is this drive to find "valid pain"? And what is the relationship, if any, between the neoliberalism (a word never used by Wailoo) of the Regan administration and the quantified body? What about quantified pain? There is an inherent incommensurability between a drive to regulate what it means to be in pain while simultaneously declaring that the production, marketing, and sale of pharmaceuticals should be deregulated. These questions are at the crux of this project.

In his conclusion, Wailoo quotes cultural historian Javier Moscoso: "'The uses of pain have nothing to do with truth, but rather with drama'" (202). Moscoso's *Pain: A Cultural History* (2012) is a sweeping review of the way pain has been addressed and portrayed over the past half millennium. Rather than organizing the work chronologically, as Wailoo and Rey do, Moscoso groups his book into themes and sub-themes (e.g., "Representations: The theater of cruelty", "Correspondence: The measure of pain", and "Coherence: Identity"). Still, the author puts a

strong emphasis on the various histories that make up how western society has understood pain, noting that his is "a book on the historical epistemology of (a certain type) of experience, on the rhetoric and persuasive means historically employed to generate conviction about the reality of pain" (2). Moscoso goes on to suggest that those who have contributed previously to pain-related discourse—including Scarry and Wittgenstein—were unable to pinpoint "where the 'culturality' of pain resides" (5). He then uses a combination of a history of science and cultural artifacts (e.g. Renaissance Era portrayals of martyrdom, Don Quixote, Leo Tolstoy's Ivan Ilyich) to illustrate this culturality. Overall, the work is beautifully written—as it was originally penned in Spanish, much of this credit should be shared by the translators—and impressively compact.

In his final chapter, Moscoso writes,

> The scientific and cultural colonization of harmful experience—the entrance of the clinical gaze into the sphere of subjectivity—neither obeyed nor can be explained through a teleological sequence which made the medicine of pain the logical conclusion of the entire suffering of humanity. (210)

If Scarry helps us understand the power exercised by the translators of pain and Wailoo dissects how political power coopts pain for its use, then Moscoso's lovely turn of phrase here—"the scientific and cultural colonization of harmful experience"—addresses what sorts of institutions put pain on the pedestal to be utilized for the exercise of power. The historian argues that medicine of pain "should be framed by the way in which our contemporary world has been able to transform continuous pain into an experience worthy of scientific research, clinical treatment, and, no less important, cultural meaning" (211). How has this transformation happened? In the remainder of this paper, I will continue to trace the cultural and scientific power of pain

measurement and visualization through a culture of classification, quantification, self-health, and statistics.

Culture of Classification

Returning to our hero, Sam, and their traversal of the insurance-related requirements of diagnosis and referrals, it is important to understand not only the multitude of classifications applied to them, but also the processes through which they are made and the history of these processes. In this section, I will review two major classificatory tools utilized for the purposes of triaging, treating, and billing conditions of both the body and mind: the *International Statistical Classification of Diseases and Related Health Problems* (ICD) and the *Diagnostic and Statistical Manual of Mental Disorders* (DSM). In doing so, we will see both that a Cold War era culture of computation accelerated the development and acceptance of these tools and how these systems of classification carry with them significant biopower.

The DSM

Until 1980, the DSM was a seldom used reference for psychiatrists. The first edition, published in 1952, was "cheap, slim, and ring-bound," while psychiatrists could "spend their working lives blissfully unaware of" the existence of the 1968 DSM-II (Cooper 2005, 1). In 1980, however, the DSM-III was released, containing a vast array of new classifications, diagnoses, and—importantly—validating data. Per Rachel Cooper, "within a few short years [of the DSM-III release], psychiatrists in the U.S. were using [it] on a daily basis" (2005, 1). This was a major edition, not only because of its eventual widespread use, but also the sorts of debates that were hashed out in its development: as two examples, PTSD was added to DSM-III, while

homosexuality was (eventually, through a revised edition in 1987), removed—both thanks to immense pressure from veteran and gay advocacy groups, respectively (Kirk and Kutchins 1992).

The development of the DSM-III was spearheaded by a psychologist named Robert Spitzer, originally trained as a psychoanalyst, but eventually attracted to a more diagnostic-focused approach (Lane 2007, 41). One main concern of Spitzer's was that the studies used to develop the underlying nosology needed to demonstrate a strong level of reliability. To that end, he and a number of colleagues published a paper in 1967 that proposed steps to increase reliability, representing a reliability metric with the Greek letter, kappa (**κ**). The paper included calculations made by a computer program called KAPPA, written in Fortran IV for an IBM 7094 computer (Kirk and Kutchins 1992, 42). As Stuart Kirk and Herb Kutchins argue in *The Selling of DSM: The Rhetoric of Science in Psychiatry* (1992), not only was the reference to a computer in the article meant to shore up support for the kappa metric, but it "also alerted clinicians that reliability problems henceforth were likely to be the province of a few research and statistical specialists who had the capability and resources to study these matters [by computer]" (42).

Kirk and Kutchins, both professors of social work, published their interrogation into the origins and consequences of the DSM-III in 1992, five years after the release of the DSM-IIIR (revised edition). Two years later, another thoroughly-overhauled edition was released, the DSM-IV, which is the target of Kirk and Kutchins' 1997 work, *Making Us Crazy: DSM: the Psychiatric Bible and the Creation of Mental Disorders*. As one might gather from the title, *Making Us Crazy* is a more aggressive argument on the cultural detriment caused by the publication and widespread use of the DSM-IV. In their conclusion, Kirk and Kutchins offer a

summary of what concerns them about the DSM. Noting that Freud's turn to dream analysis at the end of the nineteenth century represented one sort of revolution in psychological thinking, they continue, "Now, at the close of the 20th century, a revolution of similar proportions is reshaping our thinking. that de-emphasizes case analysis in favor of using checklists of everyday feelings and behaviors to identify and classify disorders" (246-7).

Certainly, the larger project at hand here is not directly concerned with the classification of behavioral disorders (though I have touched upon the relationship between pain and mental health, above). However, this checklist revolution was not unique to psychology. In expanding our focus to a system of general health classification, we might gain a better understanding of why the concept of classification is, in itself, critical to this project.

The ICD

Geoffrey Bowker and Susan Leigh Star open their 2000 *Sorting Things Out: Classification and Its Consequences* by declaring that "to classify is human" (1). Their work, which suggests that the classificatory requirements of the medical sciences are reified in both medical practice and in the design and implementation of medical tools, also provides us with some useful definitions: "A classification," they write (10), "is a spatial, temporal, or spatiotemporal segmentation of the world. A 'classification system' is a set of boxes (metaphorical or literal) into which things can be put to then do some kind of work—bureaucratic or knowledge production." Think of the segmentation that takes place in delineating between a "green" day of no pain and a "yellow" one of some pain. Consider the metaphorical boxes into which a patient's pain must be placed when deciding between faces on a scale. The authors go on (107) to offer that almost every classification scheme shares common tenets: "data

entry as work", "convergence between the medium and the message", and "infrastructural routines as conceptual problems." They also cite "the drive for universal languages" (108) as a critical element of classification systems, reminding us, perhaps, of Otto Neurath's Isotype and his efforts at "debabelization" (Neurath 1936, 13).

The authors use a number of examples from the late-eighteenth and nineteenth centuries, though they dedicate the most attention to the ICD and its accelerated development in post-World War II western culture (the ICD is a product of the World Health Organization, the arguably Eurocentric health arm of the United Nations). In keeping to one of the tenets referenced above ("data entry as work"), the pair highlights the labor intensive nature of compiling a reference such as the ICD, complete with 155,000 coded biomedical and psychological conditions[2]. While punch cards became critical to nineteenth century companies that were expanding spatially via the newly invented telegraph and extended railroad—they needed a way to standardize and replicate information production and storage—this was a very expensive and time-consuming endeavor: cards had to be manufactured out of material that was difficult to destruct, the mechanical systems processing the cards were very expensive, and specialized personnel had to be hired (Bowker and Star 2000, 126).

In the 1950s, however, electronic computerization (thanks to great investments from the government and industry during World War II) became cheaper and more accessible and punch card systems could proliferate more rapidly. "Whatever the form of integration and automation,"

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[2] Now in its tenth revision, the ICD-11 is slated for publication in 2018. Bowker and Star point out the poorly kept archives of the ICD, but suggest that the first versions of the manual were based on the work of nineteenth century physician and statistician, Jacques Bertillon.

Bowker and Star explain, “more categories were needed to manage the range of uses to which the system would be applied” (128). After World War II, the architects of the ICD took full advantage of their newly increased capacity for computationally driven statistical and classificatory analysis. “Sprawling sets of modifications were produced for specific clinical and administrative purposes” (128).

In understanding how the ever-accelerating state of quantification and classification in which our current pain-related project takes place, Bowker and Star help us when they argue that, “no matter how good the [classificatory] scheme, its scope is limited by the fact that data entry is never an easy task, and there are never enough resources or trained personnel to make it happen” (107). As planetary-scale computation and artificial intelligence take advantage of increased computing power and ubiquity, the administrative tasks of classification become automated: Sam’s handheld assistant keeps track of their every reported change in pain measurement, even passing that “interpreted” data onto their care-givers in some cases.

Bowker and Star never lose sight of the fact that these systems of classification are, in fact, designed, built, operated, and maintained by hidden figures: “we seek to understand the role of invisibility in the work that classification does in ordering human interaction” (5). In fact, they take exception to “the type of our postmodern times” wherein scholars like Baudrillard jettison questions of authorship in favor of issues that are “scientific and technological, stripped of the conditions of production” (10). In their final chapter, the authors declare that “The invisibility of infrastructure makes visualization or description difficult” (323).

That this final sentiment might call to mind the way Elaine Scarry writes about pain is not purely coincidental: each author is writing about mechanisms of power. Whereas Scarry sees the

power exercised through the revelation of pain, however, Bowker and Star recognize power as something that exists in a hegemonic system's invisibility. This is Mathew Fuller and Andrew Goffey's (2012) "grayness", a concept they adapt from Primo Levi's description of ambiguous internal politics in Nazi Lagers into a way to frame functionally banal technology. In their 2012 *Evil Media*, they write of grayness as "a quality that is easily overlooked, and that is what gives it its great attraction, an unremarkableness that can be of inestimable value in background operations" (11). And, as Bowker and Star make evident, the power here can also be understood through the lens of Foucauldian governmentality:

> The history of the lCD is thus inextricably a history of the formation of the modern state —both at the small-scale level of the development of particular bureaucratic structures and at the large-scale level of the installing of and justification for methods to keep populations under surveillance. After World War II, this development increasingly involved multinational corporations and the computerized flow of epidemiological and medical information across all manner of organizations. (123)

In looking at the invisibility of classification, we learn something about its power. In using the DSM and ICD as case studies, we are able to recognize the influence that increased computing power had on these powerful classificatory schemes, especially in the formation of the modern liberal state. Let us turn our focus, then, to ways in which to understand the computing power that drove these two systems.

Computation Culture

"We can make sense of the history of computers as tools," writes Paul Edwards in *The Closed World: Computers and Politics of Discourse in Cold War America* (1997), "only when we

simultaneously grasp their history as metaphors in Cold War science, politics, and culture" (ix). Edwards uses a combination of cultural studies (primarily interrogations of sci-fi novels and film), historiographies (for example, the use of technologies in the Vietnam and Cold Wars), and theory (including linguistic theories from Wittgenstein and George Lakoff, as well as theories of power from Foucault). He spends a great deal of time defining his conceptual terms (e.g., tool, discourse, cyborg, ideology, metaphor, et al) and defending these definitions, then uses vignettes or what he calls "scenes" to demonstrate the concepts in real world use, as well as "the ways computers and the political imagination reciprocally extended, restricted, and otherwise transformed each other" (7).

Edwards, a Professor of Information and History at the University of Michigan, reinforces a point already touched upon through our review of Bowker and Star when he argues that "the historical trajectory of computer development cannot be separated from the elaboration of American grand strategy in the Cold War" (2). He goes on to elaborate that the combination of high-tech communication, the anxiety around nuclear proliferation, a strong sense of "scientific" advancement within the administrative techniques of war management, and the United States's efforts to expand its global military control all combine to centralize command and control "at the highest levels" (6). All the while, discourse around the expansion of a culture of computation often focused on dreams of transformation while ignoring actually-acting hegemony: "Stories based on the tropes of progress and revolution are often incompatible with [the] more contingent forms of history" (xii), such as the influence of ideologies, crossover with popular culture, or political power.

In the book's final chapter, Edwards turns his attention away from the past and projects a decidedly prescient vision, especially considering the year in which the work was published. As he contemplates the possibilities that the at-the-time emerging World Wide Web might bring to cyborg discourse and subjectivity, he asks

> Can the cyborg figure still serve as a potent resource for the reconstruction of gender and other political-cultural identities along the technology/biology divide…in a world where commercial goals replace military support as the fundamental drivers of advanced computer and information technology?" (363)

Here, he recognizes the shift of primary internet participation and ownership away from government and military to private industry and global capitalism.

Continuing with forward-looking analyses, Elizabeth Wilson's argument in *Affect and Artificial Intelligence* (2011) is multifaceted in the sense that she is not only arguing for a reconceptualization of AI away from the stereotypical "cool", emotionless field for mathematicians and computer scientists and into a significantly warmer, more emotional place—she is also suggesting that the proliferation and improvement of AI technologies will increase when all parties involved agree on the aforementioned reframing. She uses biographies of both humans (chess master Gary Kasparov, computer science pioneer Alan Turing, logician Walter Pitts, et al.) and machines (IBM's Watson, virtual psychoanalyst ELIZA, its descendant, PARRY, and MIT robot Kismet), alongside theories taken from the social sciences, culture of technology, and psychoanalysis to weave a fascinating argument that challenges many assumptions we as a society have about computers and computing.

Wilson's work is important to this study for a number of reasons. Firstly, she continues to connect for us the growth of computational culture—in this case, via AI—as rooted in post-war research and investments (114; along with her own research, she points to Conway and Siegelman 2005, Hayles 1999, Heims 1991, Kay 2001, Orr 2006). Secondly, she begins to probe how our relationship to what she terms "calculating machines"—paraphrasing Bruno Latour (2004), she "advocates greater emotional attachment" to them, appealing to users: "yes, please, feel them" (xii). In doing so, she also jettisons work by scholars whose work describes a facile relationship between the user and the machine (Sherry Turkle's more recent (2011, 2015) work, while not published at the time of Wilson's publication, would still fall under this category) and amplifies those who argue for a more complicated, emotional relationship between user and device. She quotes Clifford Nass and Byron Reeves (1996, 5) "we have found that individuals' interactions with computers, television, and new media are fundamentally social and natural." How might we begin to use this framing to understand our pained user's relationship to their pain-tracking app or their consumer-grade EEG-based tool?

Wilson's research on Joseph Weizenbaum's psychoanalytic artificial intelligence program, ELIZA, indicates that the psychologist and computer scientist's work would be a logical path to follow for this project. In particular, the ways that Weizenbaum sought to reveal ELIZA's inner-workings in an effort to "detach users from their peculiar affection for it" (92) speaks to the ways that the purported "real" or "true" systems we use might wield power over said users. She notes a point at which Weizenbaum provides, perhaps, an indication of where and how we might subvert this power: "'Once a particular program is unmasked,'" he writes, "'once its inner workings are explained in language sufficiently plain to induce understanding, its magic

crumbles away; it stands revealed as a mere collection of procedures'" (Weizenbaum 1966, 36, in Wilson 92).

Finally, Wilson opens a pathway to the work of Sylvan Tomkins, whose *Affect Imagery Consciousness* (four volumes published over thirty years, starting in 1962) is a sweeping work on the way that affects and cognitive processing work together in the human psyche to help us process and utilize information. Tomkins' work is sprinkled with pain-related discourse, but one delineation that he makes, highlighted by Wilson, is between drive and affect and the density tolerances related to both: anger has relatively low density—one may wake mildly irritable or in an explosive rage, while hunger has a high density—one is hungry and gets hungrier until one eats, then hunger dissipates (76). A more thorough consideration of where pain sits on this spectrum would likely prove intellectually fruitful.

Certainly, the topics of computation and affect are large ones. What I have attempted to do in this section, however, is connect a Cold War era emergence in computational culture to the questions raised by my overall project regarding self-tracking, quantification, and classification. Having situated our history squarely in the Cold War era, it is important now to turn our attention to another phenomenon of the time, one which we might understand as leading to the proliferation of the type of self-tracking and pain-management activities referenced in our first section.

Self-Health Movement

The feminist self-health movement of the 1970s emerged out of a frustration by women's groups around the inadequacies and dangers associated with a primarily male-centric health field. In a talk given to the American Psychological Association in 1972, activist Carol Downer

(1972, 1; quoted in Ruzek 1978, 1), after a thorough list of the deplorable conditions endured by female patients, asked, “How can we rescue ourselves from this dilemma that male supremacy has landed us in?” Part of the answer to this question came before Downer’s talk, in the form of the Boston Women’s Health Book Collective’s 1970 *Our Bodies, Ourselves*, most recently updated in 2011. This canonical guide to anatomy, sexuality, care, and more was part of a groundbreaking movement for women to take their health into their own hands—be it through the “liberal feminist” view that women must make their way into the established medical field, or the “radical” approach that women must take care into their own hands (Fee 1983, 19-21).

Embracing “self-health” as a means for liberation was a logical step for women who, per Susan Cayleff (1990, 312) had been administering healthcare both at home and in the clinic for centuries. In her essay, “Self-Help and the Patent Medicine Business”, Cayleff provides an excellent, albeit brief literature review of self-health manuals and historiographies from the nineteenth century through the early 1980s. In noting that “women have also generated self-help literature warning one another of biased medical care and unnecessary surgeries” (333), she emphasizes the community-based nature of the self-health movement—something that might also be observed about the “sharable” nature of our previously touched-upon pain-tracking apps (a feature not specifically noted above, but existing in may of the applications sampled by our source studies).

By the late 1980s and into the 1990s, as major inroads were made in women’s health rights (including a decisive—albeit constantly teetering on the edge of overturn—decision by the Supreme Court on Roe v Wade in 1973), the AIDS movement found itself utilizing similar techniques implemented by the feminist health movement. Specifically, as elucidated by Steven

Epstein in his essay, “The Construction of Lay Expertise: AIDS Activism and the Forging of Credibility in the Reform of Clinical Trials” (1995; part of the work done for the longer-form work, *Impure Science: AIDS Activism, and the Politics of Knowledge*), so-called “treatment-activists” became self-educated on the methods and science behind the development of pharmaceutical AIDS treatments. They “found ways of presenting themselves as credible within the arena of credentialed expertise” (409) in order to gain an influential voice relating to how and when new drugs would become available for trial; in short, they and their friends and family were dying and they felt that not enough was being done about it. This was indicative, Epstein argues, of by then “common and rapidly proliferating phenomenon, also sometimes engag[ing] in the evaluation of scientific knowledge claims” (413).

It is important to be clear here that I do not seek to draw a straight line from the feminist self-health movement, through AIDS activism, and on to self-tracking of pain metrics via smartphone apps. Rather, I want to emphasize the homologous nature of this relationship, wherein all three are predicated on a perceived self-empowerment, reliant on input from a collective, and aimed at improving the health and care of a marginalized community. However, as Micki McGee illustrates in her 2007 work, *Self-Help, Inc.*, a post-Reagan-era self-help culture actually reifies the type of economic inequality brought on by the neoliberal concern for profit over all else (99). This was seen in the proliferation of the self-help “guru” (such as Tony Robbins or Stephen Covey) and an increasingly cutthroat management culture. “‘Excellence’ became the watchword of the 1980s, and occupational satisfaction in the pursuit of this abstraction was offered as employee motivation…managers were advised to offer employees

greater control over their work and increased input into decision-making" (132). "Excellence" in-lieu of compensation or benefits; the self-promoter deserves the success.

This problematic framing of the self as isolated and empowered leads us directly into the quantified-self movement launched in the early 2000s. As I have argued elsewhere (Schaffzin 2018; forthcoming), the self-tracking culture of the quantified self (exemplified by pain-management apps and EEG-based pain trackers) is a direct outcome of a Silicon Valley neoliberalism that preaches the individual over the collective, even as the collective is required for comparison, ranking, and competition. Remember that, per Wailoo (2015), this same Reagan-era neoliberal regime obsessed over the "medical grounds" upon which "proof" of pain would rest. Understanding this connection allows us to draw a clear line from the post-activist neoliberal self-help movement to the "proof"-providing quantified self movement and to frame this connection in the context of biopolitics, both Reagan-era and beyond. To that effect, the following section explores the the concept of biopower and governmentality as it relates to the type of statistical mechanisms utilized by these "proof"-seeking efforts.

Statistics and Biopower

To this point in our study, we have come to understand why Cold War era United States is a critical time period for the development and proliferation of computation, classification and quantification, and self-health. One more critical element of our project, however, remains to be explored: the history of statistics. Certainly, statistical mechanisms exist in nearly everything discussed here—from the various tools used to self-track pain to the programs of classification used for diagnosis and billing (the DSM, after all, is the Diagonstic and *Statistical* Manual). But statistics have a very clear history tracing back to the mid-nineteenth century during a time when

the methods used for the measurement of celestial bodies were appropriated for the determination of the "average man." This is a history covered by two major works which inform this section: Theodore Porter's *The Rise of Statistical Thinking 1820–1900* (1986) and Ian Hacking's *The Taming of Chance* (1990).

To be sure, Hacking's and Porter's works overlap quite a bit. Read together, however, they provide a nuanced and thorough history. Briefly, statistics as a governing power originates in astronomers' efforts to measure the position of celestial bodies that move. As multiple measurements on the same body were collected, laws of regression were developed to determine what the "true" measurements were—that is, if celestial body A is seen in position X more often than position Y or Z, then celestial body A must, in fact, be in position X. It was Adolphe Quetelet who decided to apply this law to human bodies: measuring a large number of men for height or chest size would result reveal in the data value that was most popular—a value that would sit in the center of a "normally" distributed set. This value was then determined to be the "true" height or chest size of the "normal" man. And thus was born the normalizing laws of statistics and the bell curve (Porter 1986, 53).

One notable difference between Porter's *Rise* and Hacking's *Taming* is in the latter's use of Michel Foucault's theories on governmentality in helping his reader understand the implementation of statistical tools for the purpose of state power[3], in particular through the history of the founding of the Prussian state. In doing so, Hacking continually points to critical moments in which keeping track of populations was a primary focus, crediting the state's

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[3] Porter does reference Foucault a number of times in his 1996 follow up, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*.

emphasis on counting people to Leibniz's argument that "the true measure of the power of the state is its population and that the state should have a central statistical office in order to know its power" (Hacking 18). Over the next hundred years (Leibniz made his recommendations in 1700), Prussia built a statistical apparatus that allowed government to both count and track a plethora of metrics about its population—the number, health, and wealth of people, to name a few. This, as Hacking points out, is a textbook example of Foucault's biopolitics "'that gave rise to comprehensive measures, statistics assessments, and interventions aimed at the entire social body or groups as a whole'" (Foucault 1980, 138, qtd in Hacking 21).

Leibniz in Prussia was not, of course, the origin of a state apparatus building its statistical apparatus. In fact, as Hacking's Prussian example ushers us into post-revolution France and through the turn of the century, statistics proliferates in a number of ways critical to our current study. Firstly, bureaucracies built upon what Hacking terms the "avalanche of printed numbers" spread throughout Europe. After a complete lack of central statistical publications being produced by Berlin, for example, there were "410 periodical publications" by 1860 (33). Secondly, a previously "antistatistical" (37) field, the moral sciences, discovered what bringing math into the mix could do. It is within this idea of a statistically driven moral sciences that we find the work of Adolphe Quetelet, Francis Galton (father of eugenics), and other promoters of the laws of regression and normalization, as well as, of course, the bell curve.

Conclusion

Majia Nadesan's *Governmentality, biopower, and everyday life* (2008) provides an excellent and succinct overview of Foucauldian concepts of governmentality and biopolitics. Though I will not be going further into her work in this paper, it is important to understand that

the ways in which counting, classifying, and organizing are not only a common thread throughout the history I have presented here, but are the ways through which power is exercised in the histories interrogated. That is, as populations are quantified and classified using opaque computational systems while simultaneously being sold a feeling of empowerment through the isolation of the self, forces of control are being exerted on them. These forces act through translation (such as from subjective experiences of pain to computable binary data) and appropriation (Scarry's torturers, for instance).

Ending this paper with the earliest examples of biopower in action may seem counterintuitive, especially in a project arguing for a primary focus on the middle of the twentieth century. It was my intention here, however, to foreground the tools and interfaces which today govern our interactions with pain measurement and tracking, providing you, the reader, with the opportunity to unfold the complex history embodied within. In *A Closed World*, Paul Edwards notes that his goal "is to balance problems in the social construction of technology with their converse, which is to say the technological construction of' social worlds" (34). On first pass, this seems to point to a determinist approach by the historian and theorist of information and technology. I want to focus, however, on the balance that Edwards is here promoting. The history of pain visualization and quantification is a complex one that cannot be attributed to one thread of technological innovation or scientific discovery. Sam's experience opens them up to multiple points of biopolitical control, but they are also seeking—and, hopefully, receiving treatment. Considering their story, however, helps us begin with the visual representations of pain, moving through the various elements which make up their multithreaded

histories, and finishing with the sources of their underlying powers elucidates the importance of a project not yet taken on by the academy.

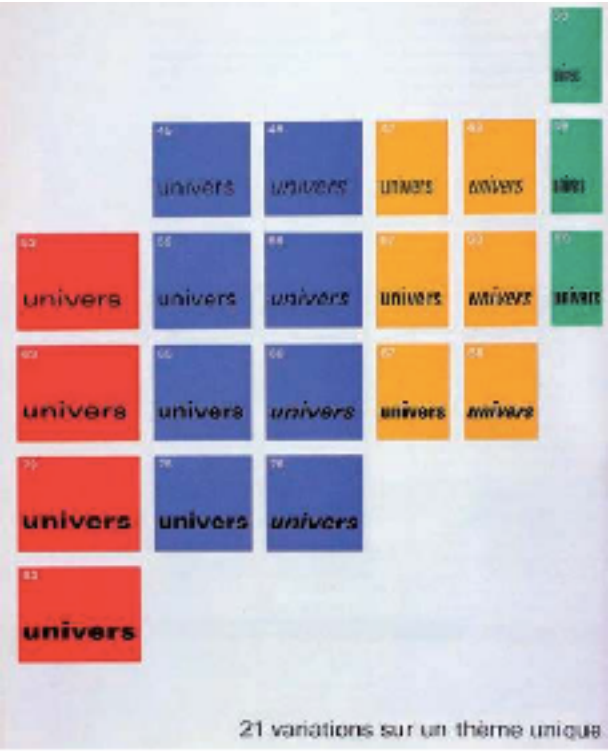

Figure 1: Univers type variations, represented as an ordered grid
(Meggs 2012, 377)

Figure 2: Unimark designers donning lab coats
1966 (from Poyner 2009)

Figure 3: Isotype "Mann" and "Frau"
Designed by Gerd Arntz (c1936) (photograph by the author, care of the curators of the Otto & Marie Neurath Archives at University of Reading. London).

Figure 4: Screenshot of smartphone application "My Pain Diary: Chronic Pain & Symptom Tracker"

Figure 5: Screenshot of smartphone application "Manage My Pain Lite"

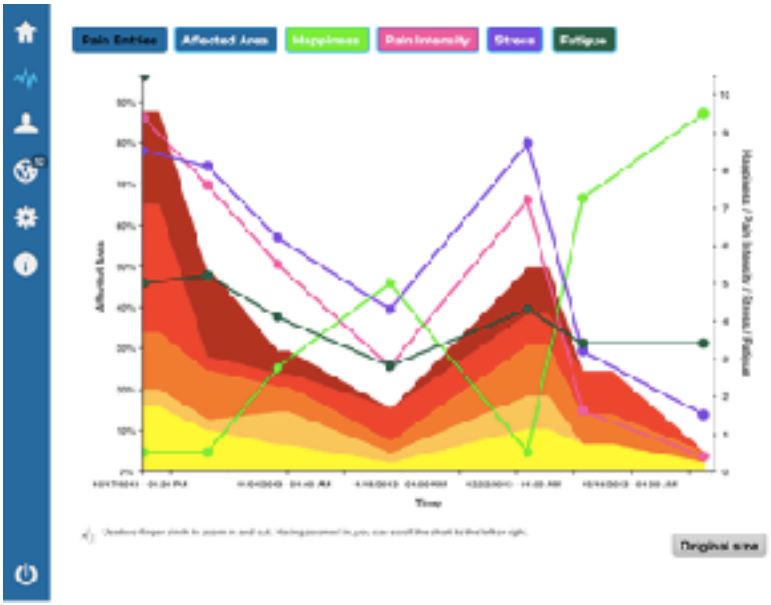

Figure 6: Screenshot of smartphone application "Catch My Pain"

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