Note: This is a draft of a potential article I have been working on. This will be the first time I have ever attempted to publish anything so any feedback would be greatly beneficial! Thank you all!

Photographs of Tone: Margaret Watts-Hughes's *Voice Figures*

Situated at the center of the composition, an oscillating vertical line cascades upwards (Fig. 1). Rooted in the foreground, the undulating waves form and extend beyond the trunk-like armature pressed close to the picture plane. Gentle, delicate limbs branch out; white where the pigment has been displaced. A faint line cuts the shape almost in half, generating a receding horizon and enhancing the depth of the odd image. At first glance, this is an object that defies easy categorization despite its simplistic form. Writer Mary Dett's description emphasizes this difficulty, as in 1889, she explained objects like this as "open[ing] a vista of marvellous possibilities both for investigating the scientific laws of sound and cohesion, and also for purposes of practical utility. At present one of the most evident modes of utilising the voice pictures is that of examining and testing by their means the tone and quality of a voice, as each vibration is accurately recorded, the figures forming as it were an exact photograph of the tone which has produced them."[1] While Dett identifies them as "photographs of tone," this object belongs to a set of objects called the *Voice Figures* which were not made a camera, nor did they register light waves through a photo-sensitive plate.

The *Voice Figures* were created by the "Eidophone" or "sound-image," an invention of Welsh singer, artist, and inventor Margaret Watts-Hughes (1847-1907) that turned vocal vibrations into shapes, forms, and figures. The Eidophone used an elastic membrane of India-

[1] Mary Dett, "Mrs. Watts Hughes's *Voice Figures*," *The Musical World* 69, no. 46 (1889): 805.

rubber connected to a rigid tube and drum.[2] Sat in a darkened room Watts-Hughes would have placed her hands around the device of her own making. With a deep breath and her lips pressed flush to the mouthpiece, she sang into this device. Vocal vibrations, which began in her body, moved down through the mouthpiece and drum, which in turn, agitated the pigments she had strewn across the attached elastic membrane. Almost magically, the mass of pigments changed. Dispersing across the surface of the membrane, the random scattering moved into recognizable geometric and organic shapes, forming the basis for objects like *Voice Figure (Tree)* (Fig. 1). By pressing a glass plate against these newly created figures, Watts-Hughes could preserve the visualization of her voice. Lacking in light-sensitive material yet still referred to as "photographs," this article examines the "conditions of possibility" around this categorization.[3] Under what conditions, what discourses or institutions, could the *Voice Figures* have possibly been called photographs? As objects that registered the vibrations of the voice rather than those made by light waves to create forms, how can they chart new narratives of nineteenth-century photography, art, and sound recording? In tracing the emergence of these sonic and optical objects, this article proposes a media archeology approach to two sets of media usually kept apart in secondary literature: photography and sound recording devices. Most scholarship has traced and analyzed the emergence of these media separately, often in dialogue with their sensorial histories of the eye/vision/light or the ear/hearing/sound, respectively.[4] Watts-Hughes's *Voice*

[2] Watts-Hughes, *Voice Figures*, 23. Different accounts describe both metal and glass being used for the structure of the base, tube, and mouthpiece.
[3] Michael Foucault, *The Order of Things* (Random House, 1970). Foucault's archaeology of examining the "conditions of possibility" around the construction of knowledge and objectivity offer a useful model in looking to why and how the *Voice Figures* could be considered photographic.
[4] For on overview on the ear, listening, and sound recording see Sterne, *The Audible Past* and for examples of vision and photography see Crary, *Techniques of the Observer* and Chris Otter, *The Victorian Eye: A Political History of Light and Vision In Britain, 1800-1910*. Chicago: University of Chicago Press, 2008.

Figures enable us to view visual and audial reproduction as associated technologies at the turn of the century united by the wave character of both light and sound.

The *Voice Figures:* Object, Image, and Media

Born on 12 February 1847 in Dowlais, Wales, Megan Watts grew up singing in school and church. From an early age, she showed great promise, eventually leaving Wales for London to train at the Royal Academy of Music.[5] Here, she worked with world renowned singers and performers, earning the King's Scholarship in 1864.[6] Singing was one of the fields that was more open to women in the mid-nineteenth century, and her voice gained her entry into the closeknit circle of Aesthetic Movement artists beginning in the 1870s whom she remained familiar with until the early twentieth century.[7] In 1885, she began the task of constructing an apparatus that

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[5] Margaret Watts studied at the Academy from 1864-1866, then reentered in 1867 and studied until 1868. See student records at the Royal Academy of Music and W. Morlais Davies, "Mrs. Megan Watts-Hughes," *Y Tyst A'R Dydd*, 30 December, 1881, https://newspapers.library.wales/view/3815509/3815518/126
She studied under famous baritone Manuel Garcia. A famous singer and inventor himself, Garcia invented the laryngoscope to better train singers. It is possible that Watts-Hughes was inspired by this for her own later invention. She trained with famous Victorian singers including
Swedish opera singer, Jenny Lind, who was also at the Academy when Watts-Hughes was there. Lind reportedly remarked, "I have never met anyone so related to me in the art of music. Two sisters only have I in the art – Madame Schumann and Mrs. Megan Watts-Hughes." See "The Watts-Hughes Voice Figures" in *The Merthyr Express*, 9th April, 1910, 9. Margaret is the Anglicized version of the Welsh Megan.

[6] See student records at the Royal Academy of Music. She was able to pay for tuition, in addition to this scholarship, from money raised by people in her community. See *Merthyr Telegraph*, March 24, 1866.

[7] Author Emilie Barrington cites her in the biography she wrote on Lord Frederic Leighton, citing how the two often performed concerts for friends and family together, see Watts-Hughes quoted in Barrington, *The Life, Letters, and Work of Lord Leighton*, 217. Another note in Leighton's biography highlights the closeness between Leighton and Watts-Hughes, as the week Leighton died, he was soliciting donations for the orphanage she ran and planning on giving a lecture there. Watts-Hughes quoted in Barrington, *The Life, Letters, and Work of Lord Leighton*, 332. A letter in the Leighton House archives from Leighton to Watts-Hughes described Leighton wanting her to return a borrowed possession. In addition, she held lectures at his house, see "The Shapes of Sounds." *Gloucester Citizen*, June 9, 1903, 4. *British Library Newspapers*, https://link-gale-com.proxy1.library.virginia.edu/apps/doc/JF3231772124/BNCN?u=viva_uva&sid=bookmark-BNCN&pg=4&xid=0f89b4fd.

would allow her to test the intensity of tones produced by the human voice.[8] Recognizing that no instrument yet existed to do so, she attached a tube, receiver, and membrane together, experimenting with different kinds of material for the membrane.[9] Her first goal in constructing what she ended up naming the Eidophone was to test the force produced by different vocal notes, measured by the movement of weights placed on the surface of the membrane.[10] Watts-Hughes was surprised to see that the seeds she had scattered over the India-rubber membrane were not "scattering promiscuously in all directions," but instead formed a "perfect geometric figure" when she sung certain notes into the Eidophone.[11] The combination of the rigid materials of the metal or glass tube and drum with the elasticity of the membrane allowed the vibrations produced in the larynx of her body to travel from the throat and mouth down the tube into the drum and up through the elastic membrane (Fig. 2). The membrane registered these vibrations through its oscillation, which in turn, jostled the substances she had strewn across the surface of the elastic. While at the time it was not known how exactly the forms generated on the surface corresponded to frequencies, singing certain notes into the Eidophone could produce the same geometric and organic forms and figures. A scientific experiment ahead of its theory and mathematics, the Eidophone and its resulting artifacts, *Voice Figures*, grabbed the attention of a wide array of audiences in the late nineteenth and early twentieth centuries who were thrilled by her visualizations of sound.

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[8] Margaret Watts-Hughes, *The Eidophone Voice Figures. Geometrical and Natural Forms Produced by Vibrations of the Human Voice*. London: Christian Herlad Company, 1904, 1.
[9] Margaret Watts-Hughes, *The Eidophone Voice Figures. Geometrical and Natural Forms Produced by Vibrations of the Human Voice*. London: Christian Herlad Company, 1904, 2.
[10] Margaret Watts-Hughes, *The Eidophone Voice Figures. Geometrical and Natural Forms Produced by Vibrations of the Human Voice*. London: Christian Herlad Company, 1904, 2.
[11] Margaret Watts-Hughes, *The Eidophone Voice Figures. Geometrical and Natural Forms Produced by Vibrations of the Human Voice*. London: Christian Herlad Company, 1904, 2.

Each of the different processes through the Eidophone shows a material, formal, and even ideological connection to photography and sound recording devices of the nineteenth century. The first kind, called "Simple Disc Figures" or "Geometrical and Floral Forms," are the simplest and share the most direct, indexical, or haptic relationship the vibration of sound. To make this kind of *Voice Figure*, Watts-Hughes would sing into the Eidophone making one long sustained note. Once the material started vibrating around the edge, she would sing a "careful *crescendo*," increasing the volume and making petal shapes dart out from the center mass.[12] This shift in volume would displace the pigment she had selected for its exact weight and viscosity through her vocal vibrations. The shape would not be formed all at once, nor easily. In fact, Watts-Hughes writes that it took time for different "stages of development" to produce a "fully developed" daisy or floral form.[13] It was a process of trial and error, experimentation and failure from start to finish. Negotiating the materiality of the paste placed at the center was central to how the pigment moved with the notes Watts-Hughes sang. Then, she would have to perfect the notes, singing through the device while monitoring the pigment at the center to sing in the waves mentioned. This aspect of the creation through the Eidophone drew inspiration from two earlier inventions: the Chladni figures and the Phoneidoscope.

In the late eighteenth century Ernst Florens Frederich Chladni (1756-1827), a German musical instrument-maker and physicist was able to "see" sound, or at least the invisible movements propagated from sound waves.[14] With a square plate, some sand, and a violin bow,

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[12] Margaret Watts-Hughes, *Voice Figures*, London: Hazell &Watson, 1891, 15.
[13] For this language see Margaret Watts-Hughes, *Voice Figures*, London: Hazell &Watson, 1891, 15. Voice Figures, 15 and "Voice Figures, and What They Are," *Pall Mall Gazette*, 12 February 1890.
[14] While Chladni is usually described as the first, his experiments owed a great deal to much earlier scientific experiments with sound done by Robert Hooke and Galileo. See Chitra Ramalingam, "Dust Plate, Retina, Photograph: Imaging on Experimental Surfaces in Early Nineteenth-Century Physics." *SCIENCE IN CONTEXT* 28, no. 3 (September 1, 2015): 317–55. doi:10.1017/S0269889715000125.

Chladni could run the violin bow along the edge of the plate covered in sand — in essence, playing the plate and setting it in motion (Fig. 3). This would in turn, agitate the sand where it would vibrate away from where the plate oscillated in three-dimensional motion, coming to rest in piles on where the plate was inert. The sand made patterns that varied from simple to more elaborate geometric forms, offering a "negative" image of sound (Fig. 4).[15] For the first time, sound had depicted itself. We know that Watts-Hughes was familiar with the Chladni figures and must have considered them while inventing the Eidophone as she refers to Chladni on the first page of the introduction of her book, *The Voice Figures* (1891).[16] Beholden to Chladni's earlier experiments, the Eidophone also uses a two-dimensional surface to register a three-dimensional sonic, vibratory event. The other technology she directly cites is Professor Sedely Taylor's (1834-1920) Phoneidoscope. A contemporary to Watts-Hughes, Sedley Taylor was a professor at Cambridge University. In 1878, he used some of Helmholtz's theories to invent the "Phoneidoscope."[17] The Phoneidoscope was an instrument that used a brass tube attached to a wooden mouthpiece. Instead of the elastic membrane of the Eidophone, the Phoneidoscope used a "thin film of liquid glycerin," usually castile soap, in order form a soap bubble. When the bubble was set into motion from "sonorous vibrations," it would change colors, moving and altering form as a note was sustained.[18] It is safe to assume that Taylor and Watts-Hughes had a

[15] Tobias Wilke, *Sound Writing: Experimental Modernism and the Poetics of Articulation* (University of Chicago Press, 2022), 35.
[16] Margaret Watts-Hughes, *Voice Figures*, London: Hazell &Watson, 1891, 7.
[17] For information on the Phoneidoscope, see Sedley Taylor, "Sound Colour-Figures," *Nature*, 28 March, 1878, 426-427. For the invention itself see Whipple Musuem object accession number 2012: https://collections.whipplemuseum.cam.ac.uk/objects/9810/
[18] Sophie B. Herrick, "Visible Sound, Voice Figures,", *Century Magazine,* May 1891, 43

working relationship, as he wrote to defend her scientific and acoustic accomplishments after a newspaper obituary had diminished them as a kind of hobby or woman's work.[19]

Generating the shape is only the first part of forming the *Voice Figure,* however. Objects like *Voice Figure* (Fig. 5), are preserved records of a performance. Disrupting the mix of watercolor and other substances on the elastic disc, the shapes formed on the surface of the disc and would then be transferred while vibrating and fixed by pressing them against a prepared glass sheet for preservation.[20] Once the motion stopped in the case of the Chladni figures and the Phoneidoscope, the image and artifact of sound fell apart – becoming sand on a plate or a film of soap wholly reliant on the experimental and active part of their making rather than existing in the world as image and object. Taylor explicitly did not make illustrations of his "Sound Colour-Figures" produced by the Phoneidoscope, writing that reproductions of them were unable to capture "their beauty of form and splendour of hue."[21] Illustrations of the Chladni figures were included in his 1787, *Entdeckungen über die Theorie des Klanges* (*Discoveries in the Theory of Sound*) (Fig. 4). In plates at the end of the text, Chladni includes simplified illustrations of the outcomes of his experiments but would often perform the experiment to show the figures in motion. The illustrations of the Chladni figures seem to suggest that the figures are stable or static, when this is not the case.[22] While the act of creation of the shape recalls other earlier sound experiments in both the construction of the Eidophone and the form produced, its

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[19] "The Late Mrs. Watts Hughes," 1908.*The Musical Herald* (718): 7. https://proxy1.library.virginia.edu/login?url=https://www.proquest.com/historical-periodicals/late-mrs-watts-hughes/docview/7118770/se-2.

[20] This process is described more at length, especially the "transferred while vibrating," in Royal Society Conversazione catalogue of June 1888, https://catalogues.royalsociety.org/CalmView/Record.aspx?src=CalmView.Catalog&id=PC%2f3%2f1%2f30&pos=9

[21] Sedley Taylor, "Sound Colour-Figures," *Nature*, 28 March, 1878, 426-427

[22] This is described in further detail in Chitra Ramalingam, "Dust Plate, Retina, Photograph: Imaging On Experimental Surfaces In Early Nineteenth-Century Physics." *SCIENCE IN CONTEXT*, vol. 28, no. 3, 1 Sep. 2015, pp. 317 - 355, doi.org/10.1017/S0269889715000125.

preservation or fixation is more closely aligned with other kinds of artmaking practices including printmaking or photograms.

The act of transference from dynamic scientific experiment to static artwork and object is an act of haptic contact with the object to be imaged. In this way it aligns itself with photograms, objects like Anna Atkins' mid-nineteenth-century cyanotypes of different flora and fauna (Fig. 6). Both are at scale, direct representation of the material object that then represent. Both are singular negatives, materializing and recording their scientific object of study as solitary object rather than an infinitely reproduceable image. Formally, the objects also look quite similar. Small, fragile, and delicate, sitting in the center of this *Voice Figure* is a yellow, 18-petaled shape (Fig. 5). With a flat black painted background and very little detail, the form is isolated against a flat, planar color field. Flattening details and rendering the subject as a monochromatic silhouette, they are presented in a kind of nonspace. Made through contact with sensitive surface that materializes the object of study against an abstract, compressed space, this *Voice Figure* transforms vocal vibration into a flower image, entering it into a visual lexicon with other cameraless photographs, noted by other nineteenth-century writers. While remarking on the "fern" type of *Voice Figure*, a writer noted that they appeared to be "printed straight from the ferns themselves" the exact language used to describe Atkins' own fern cyanotypes.[23]

[23] "Singing at Sight." *Daily News*, 23 July 1891. *British Library Newspapers*, link-gale-com.proxy1.library.virginia.edu/apps/doc/BA3203234294/BNCN?u=viva_uva&sid=bookmark-BNCN&xid=cc14ed1a. The comparison between early photography and sound experiments has also been made by historian of science Chitra Ramalingam who examined the sound experiments of Wheatstone and Faraday (building from Chaldni) against Henry Fox Talbot's early experiments with photography. Ramalingam shows that each technology took a dynamic, temporal event and turned it into a visual, static one that could become accessible to the eye. She argues that it is this aspect of each media that is essential, and therefore that photography's place of privilege in histories of fixing ephemerality has been wrongfully bestowed. Photography, instead, served as one potential approach among many others. Chitra Ramalingam, "Dust Plate, Retina, Photograph: Imaging On Experimental Surfaces In Early Nineteenth-Century Physics." *SCIENCE IN CONTEXT*, vol. 28, no. 3, 1 Sep. 2015, pp. 317 - 355, doi.org/10.1017/S0269889715000125.

The second kind of *Voice Figure* require slightly more manipulation. For this kind, called "impression figures," Watts-Hughes would coat both a plate of glass and the elastic disc with a thin layer of watercolor and then lay the plate on top of the disc. By varying the notes sung into the Eidophone, the plate would break adherence from the disc, and thus change the form of the image produced. This differs from first kind because the rigid glass sheet actively participates in the making of the image. Rather than becoming the support and recording surface at the end of the process, here it is integral. The resistance of the glass and the way it dislodges from the elastic membrane is what produces these vibratory, adhesion, cohesion, and displacement interference patterns. According to her the image made depended on "the pitch of the note sung, the rapidity with which the plate is lifted from the vibrating disc, and the preparation of the disc and plate."[24] The material makeup could shift the resulting image drastically – the viscosity of the liquid and weight of the pigment altering the adherence of the elastic to the glass plate. Through this method, she was able to get cross-vibrational patterns which added great depth and energy to the image produced, even producing objects that seemingly mimicked painted perspective. In an image like this, the careful control and interference patterns project a sense of depth or movement, making something that resembles a tree (Fig 1). By calling *Voice Figures* like this "tree forms," Watts-Hughes's *figures* her voice, making a claim that this object, through the registration of sound, represents a tree. She forces it into a different register. It turns from a series of vibrating, displaced pigment into a picture, becoming imagistic. Photography shares this same tension. As Joel Snyder argues in "Picturing Vision," the camera and its pictorial mode are not an automatic giver of natural images, but a historically constructed tool and instrument that mimics Renaissance painting perspective.[25] It is not enough to capture the ephemeral qualities,

[24]Margaret Watts-Hughes, *Voice Figures*, London: Hazell &Watson, 1891,
[25] Joel Snyder "Picturing Vision." *Critical Inquiry*, vol. 6, no. 3, 1 Apr. 1980, pp. 499 - 526.

instead each technology seeks to make a *picture*, one that constructs depth and space, creating a "window onto the world" that it aligns itself with painterly modes of vision.

Finally, Watts-Hughes introduced an adaptation on the Eidophone which she called the "Hand Eidophone" (Fig. 7). This variation meant that larger works could be made and multiple performances recorded on the same glass plate. She would pre-paint both the glass and the disc, and lay the plate wet-side up. Then, singing into the device, she would vibrate the disc, which in turn, when pressed to the plate would vibrate the painted surface. Gliding over it would leave behind "a register of every vibration recorded in the strictest accuracy."[26] Interested in creating what she describes as certain "perspective effects" through this multilayering mode of recording her voice, the resulting *Voice Figures* vary even more drastically than the disc or impression figures.[27]

For a *Voice Figure* like this one (Fig. 7) there are different tones and shades as she layered the waveform shapes over one another. A shocking spray of green across a delicate glass plate transforms the translucent sheet into an energic field of concentric circles. Within these circles are darker pinpricks of color that converge and overlap forming a moiré or interference pattern. The sonic space is layered and pulsating with no clear sense of direction for this object, no idea of orientation. Each vocal trumpet is at least one gesture and one sustained note, so what we see are countless instances of song, frozen in time and moved from three-dimensional, rounded space onto a two-dimensional static plate. The vibrating, quivering quality of painted surface rematerializes the sonic component of its making. Through the visual, it evokes the haptic, the audible, and the vibratory.

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[26] Margaret Watts-Hughes, *Voice Figures*, London: Hazell &Watson, 1891.
[27] Margaret Watts-Hughes, *Voice Figures*, London: Hazell &Watson, 1891, 23.

As each waveform is made through a vocal vibration moving across a pre-painted plate, the Hand Eidophone evokes other early sound recording media like Édouard-Léon Scott de Martinville's 1857 phonautograph. From Chladni, many historians of acoustics jump to the phonautograph as the next important touchstone in visualizing sound, and the first in the category of "graphic trace," and as such, is often understood in the first direct link to the phonograph. A large cylindrical or conical object was fitted with an elastic membrane on the smaller end. Scott attached a sharpened stylus made out of organic materials, like feathers, which would etch into paper covered with black soot. Through the combination of rigid and elastic materials, Scott was able to capture sound – vocal vibrations made through the cone were etched onto the paper (Fig. 8). In this "recording," the song was sung and fixed into the sooted paper, drawn into the charcoal. For the phonautograph, the sound waves are suspended and trapped on the sooted page. The tip of the feather etches into the charcoal, it's very material captured through its displacement. Likewise, Watts-Hughes *Voice Figures* inscribe sound waves through material displacement. Both the Hand Eidophone and the phonautograph work through this material resistance, capturing and fixing vocal waves. And Scott de Martinville's language and materials prompt comparisons with photography, muddling distinctions. The phonautograph provided an indexical, fixed representation of sound and the voice – one that Scott considered comparable to photography, stating that: "Gentlemen, I am going to announce to you a piece of good news: sound, as well as light, furnishes a durable image at a distance; the human voice is written by itself."[28] Scott de Martinville's goal was to create a device that would do for sound what photography had done for light, making an image of nature and fixing it. Scott de Martinville not only calls out the photographic process by name, but by writing that it could be

[28] *The Phonautographic Manuscripts*, 23.

"written by itself," he returns to some of the earliest writings about photography. William Henry Fox Talbot, British inventor of calotype photography, wondered if it would be possible to "cause these natural images to imprint themselves durably, and remain fixed upon the paper" in his treatise on his invention of photography, *The Pencil of Nature.*[29] Scott de Martinville inserts himself, and the phonautograph, within the technological discourse of photography, claiming that both types of technology give nature the ability to image itself, removing the hand of the scientist or artist. Outside of the rhetoric used to describe these inventions, Scott de Martinville's process used the materials of photography as well. To fix the images, he would use a bath of egg whites, the same egg whites of albumen silver print photography invented a decade earlier.[30] Never was Scott de Martinville's goal to replay sound, instead he understood the visual output of the phonautograph as "a process of…drawing by sound."[31] He was not concerned with the potential to capture sound and replay it, rather that sound should be captured into the realm of vision and preserved.

The phonautograph's media history is tied to accounts of Thomas Edison's phonograph.[32] Sharing a similar process, the two devices had incredibly different goals. Edison's phonograph became the first machine to register, fix, and replay sound in 1877. Once Edison had succeeded in replaying sound that became the critical operation for other sound recording devices at the turn of the century. However, this account of the media's history loses sight of its ties to optics and photography. Looking at Watts-Hughes, Taylor, Scott de Martinville and Chladni, we can see how essential a component the visual played in their experiments with sound. None of their

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[29] William Henry Fox Talbot, *The Pencil of Nature* (Longman, Brown, Green, and Longmans, 1844), 4. It is unknown if Scott de Martinville had read *The Pencil of Nature* despite using incredibly similar language. Regardless, it shows a drive to have nature depict itself, see Batchen, *Burning with Desire*.
[30] *The Phonautographic Manuscripts*, 13-14.
[31] *The Phonautographic Manuscripts*, 52.
[32] Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction*, Duke University Press, 2003.

inventions attempted to replay sound as sound, instead, sound was represented through a visual process. Neither replay-ability nor inscription serve as the essential functions for all sound recording technology, instead, it is the idea of a "drawing by sound" – each sonic artifact has served its purpose merely by existing as a figure or form on a sensitive plate. In contrast to the acoustic and media histories that have manufactured a "phonographic regime" or the "cult of Edison," these processes are not replay-able.[33] They were designed to be fully visible and to create a picture of sound. From the very beginning sound recording technology's earliest ancestor was visual with Chladni and this lineage includes Watts-Hughes and more "traditional" phonographic media like the phonautograph, moving them closer to the discourse of photography.

Through Watts-Hughes's Eidophone and *Voice Figures* we can see the interconnected histories of these two media. Each technology registered and fixed something impermanent and immaterial, fashioning an image that reportedly represented the real, external world. At the heart of these technologies was the image and its haptic, indexical, recorded trace with the thing it represents. Photography was not the sole medium that registered the world and represented it; instead, sound recording devices like the Eidophone also fashioned pictures from mechanical registrations.

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[33] Andrea F. Bohlman and Peter McMurray, "Tape: Or, Rewinding the Phonographic Regime," *Twentieth-Century Music* 14, no. 1 (2017): 7-8, https://doi.org/10.1017/S1478572217000032. Bohlman and McMurray describe the principles that have been inflected in all sound studies: "all sound media are part of the same lineage; that lineage begins with the phonograph; sound recording is an act of inscription – of writing sound; sound media record everything indiscriminately, documenting (or perhaps creating) the Lacanian real; they especially capture the afterlife of the real, embalming the voice of the dead for future generations; and sound recording is an indexical process where time and sound are co-constituted and inextricably linked." I have added that sound studies prescribes a "replay-ability" to early devices as there are continuous attempts to replay the earliest sound recordings, for example in the First Sounds Project by Patrick Feaster. For "cult of Edison" and "cult of invention" see Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction* (Duke University Press, 2003), 28.

Exhibiting, Categorizing, and Circulating the "Photographs of Tone"

After her 1885 discovery, Watts-Hughes exhibited and published about the *Voice Figures* in a variety of different venues. In 1888 she exhibited them at one of the evening Soirées or Conversazioni held by the Royal Society in London.[34] The Royal Society was one of the premier scientific institutions in London and by the 1870s and 80s, it had expanded its programming to include exhibitions open to women in 1876.[35] When Watts-Hughes displayed the *Voice Figures* in 1888, she became the first woman to exhibit an invention to the Royal Society.[36] For the Royal Society, the *Voice Figures* were exhibited in the "Principal Library" alongside other contemporary scientific inventions like James H. Robertson's telautograph or "writing telegraph" and even Sedley Taylor's Phoneidoscope as well as more natural history type specimens including live electric eels, ant nests, and photographs of nebulas.[37] Ratifying the scientific contribution of the *Voice Figures*, the Royal Society considered it an invention worthy of display akin to many other cutting edge technologies. In this venue the *Voice Figures* were deemed more "scientific" – a contribution to the sciences of acoustics, mathematics, and physics.

A year later, in 1889, Watts-Hughes exhibited the *Voice Figures* at the second Arts & Crafts Exhibition Society. Situated in the gallery between a painted screen and a display of books, the *Voice Figure* display included "wave, line, flower, tree, fern" with some looking "very

[34] Programme for a Royal Society conversazione, 6 June 1888, Reference number: PC/3/1/30 https://catalogues.royalsociety.org/CalmView/Record.aspx?src=CalmView.Catalog&id=PC%2f3%2f1%2f30&pos=9
[35] Although the institution had expanded its programming, women were only allowed to attend and present at one of the events, the event in June. The conversazione in May remained exclusively men.
[36] While not mentioned in the accompanying program, it seems very likely the Eidophone was displayed alongside the *Voice Figures*. A newspaper illustration of the event shows the devices alongside the works. *Conversazione of the Royal Society* by J. R. Brown, 1888.
[37] Programme for a Royal Society conversazione, 6 June 1888, Reference number: PC/3/1/30 https://catalogues.royalsociety.org/CalmView/Record.aspx?src=CalmView.Catalog&id=PC%2f3%2f1%2f30&pos=9

remarkably [like] the natural objects named."[38] The catalogue favors this description and that they are a "discovery of Mrs. Watts Hughes" rather than the materials or mode of making unlike many of the other entries. Amongst an assortment of decorative objects ranging from embroidery to painted roof tiles, they apparently caused a great stir, with people jostling to see them.[39] Despite previously being shown as scientific objects, one reviewer referred to them as "pseudo-scientific trifling" that had no place amongst works of art.[40] In this context, the *Voice Figures* are recognized for their aesthetic, even ornamental or decorative contribution. The Arts & Crafts Exhibition Society endeavored to create a "revival of design and handicraft, the effort to unite—or rather to re-unite, the artist and the craftsman, so sundered by the industrial conditions of our century—has been growing and gathering force for some time past."[41] Seeing the growing state of industry and industrialism as killing art and beauty, the Arts & Crafts Exhibition Society uplifted decorative art and handicraft, exhibiting it like fine art. In this way, the *Voice Figures* seem to be abstracted from their mode of making, shown solely for their beauty. In fact, in the preface to the catalogue, Walter Crane writes that the show "is a protest against the turning of men into machines" despite the *Voice Figures* being considered a kind of sound media or technology just the year before.[42]

Moving between artistic and scientific spaces and contexts, the *Voice Figures* are not unsimilar to the state of photography in the nineteenth-century. Photography's tension as a mechanical mode of representation that still adhered to Renaissance ideas of perspective placed

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[38] *Arts & Crafts Exhibition Society. Catalogue of the Second Exhibition*, London: The New Gallery, 1889, 233 https://archive.org/details/ACESExhib02AAD19801798/page/n233/mode/2up?view=theater
[39] "Exhibition of the Arts and Crafts," *Glasgow Herald*, 9 October 1889.
[40] "The Second Arts and Crafts Exhibition," in *The Art Journal*, December 1889, 363.
[41] Walter Crane, "Preface," *Arts & Crafts Exhibition Society. Catalogue of the Second Exhibition*, London: The New Gallery, 1889, 9.
[42] Walter Crane, "Preface," *Arts & Crafts Exhibition Society. Catalogue of the Second Exhibition*, London: The New Gallery, 1889, 10.

it at odds with other artistic media.[43] Even the Arts & Crafts Exhibition Society seemed wary of photography's place in art as only five photographs are shown in 1889.[44] While certainly "fine art" photographers worked and exhibited in nineteenth-century London photography's hybrid or liminal status resisted it becoming a privileged medium of fine art. Considering their varied exhibition history, the *Voice Figures* are stuck same tension as photography, between venues, discussions, and categorizations of both art and science.

Mary Dett's 1899 explanation and review in London's preeminent music newspaper, *The Musical World* picks up on this same tension with her final line – "photographs of tone." While perhaps a quick analogy, the rest of the article reads with clarity and precision.[45] By finishing with this categorization, she emphasizes the correlation between the *Voice Figures* and nineteenth-century photography, at once making a claim that the *Voice Figures* are an "accurate" representation of sound, just as photography is of light. Dett was not alone in this categorization. Watts-Hughes's 1891 publication is referenced as "photographic literature" in *Photography, its materials and appliances*. Published in 1895, *Photography, its materials and appliances* sought to provide an overview for beginners interested in the topic. Beginning with a brief explanation on the range and capabilities of photography covering everything from astronomical photography to stereoscopic photography, the manual claims that "the photographic lens sees and reproduces what is imperceptible to the human eye."[46] If this is the definition of photography that

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[43] According to John Ruskin, "They [Photographs] supersede no good art for the definition of art is 'human labour regulated by human design' and this design or evidence of active intellect in choice and arrangement, is the essential part of the work, which so long as you cannot perceive you perceive no art whatsoever; which when once you do perceive you will perceive also to be replaceable by no mechanism."
Ruskin quoted in Harvey, Michael. "Ruskin and Photography." *Oxford Art Journal* 7, no. 2 (1984), 31 http://www.jstor.org/stable/1360290.

[44] *Arts & Crafts Exhibition Society. Catalogue of the Second Exhibition*, London: The New Gallery, 1889, 233 https://archive.org/details/ACESExhib02AAD19801798/page/n233/mode/2up?view=theater

[45] Dett describes the connection to Chladni and material requirements of producing the *Voice Figures* in Mary Dett, "Mrs. Watts Hughes's *Voice Figures*," *The Musical World* 69, no. 46 (1889).

[46] *Photography, Its Materials and Appliances,* London: John Birch and Co, 1905, 7.

the manual adopts it makes perfect sense that the 1891 edition of *The Voice Figures* would be referenced as further reading material. The Eidophone similarly sees and reproduces that which is "imperceptible to the human eye". Referenced as "photographic literature" despite not actively being about photography or even the process of photographing the *Voice Figures* enhances the categorization of sounding media as "photographs" as these are both technologies that share the ability and goal to "see and reproduce what is imperceptible to the human eye."

Due to the publication of her book and an 1891 *Century* magazine article, the *Voice Figures* were also transmitted and circulated as photographic prints, specifically as collotype prints and photographic halftone prints.[47] The second edition run of *The Voice Figures*, *The Eidophone Voice Figures: Geometrical and Natural Forms Produced by Vibrations of the Human Voice*, was published in 1904 and used a halftone photomechanical process to make the accompanying illustrations. The halftone photomechanical process is an intaglio printing process that begins with photographing a photograph through a gridded glass screen.[48] The intersecting perpendicular lines each act as an aperture, registering the waves of light penetrating the screen as a series of points on to the light-sensitive plate behind it. To make the illustrations included in the book, each of the *Voice Figures* would have been photographed through this grid. Through this process they are transformed into a photograph for public consumption. A reader of *The Eidophone Voice Figures: Geometrical and Natural Forms Produced by Vibrations of the Human Voice* would have seen photomechanical reproductions of the *Voice Figures*, experiencing them as printed group of dots that were made through photography. These halftone dots cultivate some of the interference patterns of the *Voice Figures*. The noisy, oscillating, and

[47] These conclusions are based from my own observations of the printed illustrations.
[48] Jennifer L. Roberts, *Contact: Art and the Pull of Print*. Princeton: Princeton University Press, 2024, 137.

jarring moiré effect is compounded through the halftone amplifying the *Voice Figure*'s vibratory and sonic facture (Fig. 9). In other words, its translation into a photographic mode affirms the objects' connection to sound.

While the 1891 halftone reinforces the moiré, the collotype illustrations in the 1891 edition emphasize a different connection to photography. Collotype printing had its heyday from about the 1870s to the 1920s as it could reproduce photographs, but was a tricky process that could never be fully mechanized.[49] A planographic or lithographic process, collotype relied on the incongruity between ink and water.[50] Unlike lithography or other printing processes, the matrix for collotypes is created when gelatin reticulates, the process when gelatin wrinkles and puckers after being exposed to extreme temperatures. Collotype relies on this irreversible principle. After a glass plate is coated with a hot gelatin and a light-sensing bichromate mixture, the plate is then exposed to a glass photographic negative. Sunlight streams through the negative onto the surface of the plate. Where the plate is exposed the most, the gelatin will most heavily reticulate after a bath of cold water. Once reticulated, it becomes very hard and dense, repelling water and only taking ink when printed. This means that the most exposed areas on the negative become the darkest areas on the matrix and vice versa. Collotype's signature is its small, "wormy," irregular surface when magnified (Fig. 10).[51]

Many of the collotype prints seem to have started from a photograph of one the *Voice Figures*. For example, the illustrations of the "tree figure" *Voice Figures* have the same black and white tonalities of the original object implying that they were photographed with the negative being used to expose the glass matrix of the collotype. However, I think it is possible, perhaps

[49] Richard Benson, *The Printed Picture*, 244-253
[50] Richard Benson, *The Printed Picture*, 244-253
[51] Richard Benson, *The Printed Picture*, 244-253

even likely, that certain *Voice Figures* were actually treated as photographic negatives in the translation of the object into collotype print. The illustration on page 38 of *The Voice Figures* shows what the lowest C note looks like when sung into the Eidophone (Fig. 11).[52] While it does not appear to be the exact same object, there is an existing *Voice Figure* showing the same note (Fig. 12). The highlights and lowlights of these two C notes are completely reversed. In the original object each overlapping circle is denoted with an absence of blue pigment and the contours formed by the light shining through the transparent glass. In the collotype in the book, however, the rings are formed by a dark, thick band. The shades of light and dark are reversed from one another, made especially clear with the opaque paint at the bottom of the vocal trumpet in the original object and the pure white streak in the collotype. One way that this could have occurred is if the *Voice Figure* was used as the photographic negative in the printing process. Held against the glass matrix, light would have shown through the bands of concentric circles, exposing the gelatin mixture to more sunlight. These exposed areas would have hardened more than the areas around them, taking on more ink and resulting in the heavy black tones seen on the final page.

Acting as its own photographic negative to create a printed photographic illustration literalizes the *Voice Figures*' comparison to photography. In their reproduction they *become* photographs, bearing the same critical and operative objecthood as other photographs. While Mary Dett determines that they are photographs before their translation into collotype or halftone, these processes reinforce this determination.

[52] Margaret Watts-Hughes, *Voice Figures*, London: Hazell &Watson, 1891, 38.

Light and Sound

By categorizing the *Voice Figures* as "photographs," they overturn almost every definition that photography must be a physical and chemical registration of photons, of light. While I have already proposed that this is due to forgotten similarities between sound recording and photography as well as how the *Voice Figures* were exhibited, received and circulated, I want to offer one last explanation on how and why they could be considered photographs - the intertwined histories of light and sound at the turn of the century. While today we recognize that light behaves like two different physical phenomena, a wave and a particle, called the "wave-particle duality of light," in the mid- to late- nineteenth century it was considered to behave exclusively like a wave. Already light's status had shifted once: Iaasc Newton's *Opticks* had argued that light moved as a stream of particles, but this was overturned in the early nineteenth century when British scientist Thomas Young conducted the slit experiment proving that light interfered with itself and had to, therefore, move as a wave.[53] James Clerk Maxwell's 1873 book *A Treatise on Electricity and Magnetism* fortified this theory. Maxwell compares light to other electromagnetic forces, writing that the "undulatory theory of light also assumes the existence of a medium."[54] Light was an undulating wave that required a medium, like sound waves do, to propagate and move. This all changed with Albert Einstein's 1905 discovery of the photoelectric effect.[55] While it was widely challenged, Einstein showed that light must have properties of both

[53] Henriksen, Ellen Karoline, Carl Angell, Arnt Inge Vistnes and Berit Bungum. "What Is Light?." *Science & Education*, vol. 27, no. 1/2, 1 Mar. 2018, pp. 82, doi.org/10.1007/s11191-018-9963-1. And Walborn, Stephen P., Marcelo O. Terra Cunha, Sebastiao Padua and Carlos H. Monken. "Quantum Erasure." *American Scientist*, vol. 91, no. 4, 1 Jul. 2003, pp. 336,
[54] James Clerk Maxwell, *A Treatise on Electricity and Magnetism*, Oxford: Clarendon Press, 1873, 383.
[55] Henriksen, Ellen Karoline, Carl Angell, Arnt Inge Vistnes and Berit Bungum. "What Is Light?." *Science & Education*, vol. 27, no. 1/2, 1 Mar. 2018, pp. 82, doi.org/10.1007/s11191-018-9963-1. And Walborn, Stephen P., Marcelo O. Terra Cunha, Sebastiao Padua and Carlos H. Monken. "Quantum Erasure." *American Scientist*, vol. 91, no. 4, 1 Jul. 2003, pp. 336.

a wave and a particle which is how we now understand it. However, for most of the nineteenth century light behaved as a wave linking it in a material and metaphorical way to sound.

Sound and light's relationship was no mere analogy as its conflation had real scientific and pedagogical significance. Watts-Hughes's *Voice Figures* illustrate sound's potential to be considered photographic, but the technology of one of her contemporaries, American physicist Robert Williams Wood (1868-1955), better demonstrates the exchangeability of light and sound at the turn of the century. Wood is perhaps better known in the history of photography because of his developments of infrared and ultraviolet photography; however, one of his first contributions was the photography of sound waves. Using shadowgraph, a practice where ephemeral, invisible phenomenon like heat can be seen through a photograph of their shadows, Wood adapted an existing experimental setup to photograph the behavior of sound waves. Based on a Toepler system, Wood substituted a telescopic lens for a camera. A spark is started between the two brass balls, which in turn, charges a Leyden jar that acts as a battery for the second spark. This second spark lights after the first has already been ignited, but before the sound wave made by the rapid snap of the spark has gone beyond the edge of the camera's lens. Wood controlled the sparks to emit once and for only an instant, generating a singular sound wave which was then photographed (Fig. 13). Referenced in an unpublished letter to physicist Charles Vernon Boys, Wood first writes of his excitement of his discovery and its use in tracking how sound waves move and form under different conditions.[56] Wood includes drawings of the shapes in the blank spaces of the letter (Fig. 14) emphasizing and tracking the visual component that the photographs of the sound waves offer.

[56] Letter from Robert Williams Wood, Department of Physics, University of Wisconsin, 237 Langdon Street, Madison, Wisconsin, to Charles Vernon Boys, 10 December 1899, Royal Society Archive, Reference Number: MS/928/2/194.

Wood first published his findings in the *Philosophical Magazine and Journal of Science* in 1899, beginning the explanation of his findings with the driving force for its invention: "It occurred to me that if these waves could only be photographed, a most valuable set of lantern-slides could be prepared for illustrating to students the changes in the form of the wave-front… In teaching the subject of optics we are compelled to resort to diagrams when dealing with the wave-front, and the student is apt to get the idea that it is merely a sort of conception, and that the ray is the real thing. I have found these pictures of sound-waves very valuable in checking this notion…"[57] While the 1899 publication does not include the photographs, his 1900 papers, both titled "Photography of sound-waves, and the kinematographic demonstration of the evolutions of reflected wave-fronts" do.[58] The wave motion of sound waves appears in a faint deviation from the gray background (Fig. 13). Converting the various forms back to drawing and then overlaying them in a diagram, Wood helped students understand that those "obnoxious rays" had real, physical consequence in their formation as waves.[59] Wood was not particularly interested in sound itself but in using sound as analogy for light, using sound waves in lieu of light waves themselves.[60] He found that physics students could not easily visualize and understand the way the light waves moved and wanted to provide to them a model. Significantly, these are used as pedagogical tools for physics students, reinforcing for a new generation of scientists that sound and light share the same properties.

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[57] R.W. Wood, "Photography of Sound-Waves by the 'Schlieren-Methode'," *The London, Edinburgh and Dublin Philosophiocal Magazine and Journal of Science*, August 1899, 218.
[58] Robert Williams Wood (R. W. Wood) and Charles Vernon Boys, "Photography of sound-waves, and the kinematographic demonstration of the evolutions of reflected wave-fronts," Proceedings of the Royal Society of London Volume 66, Issue 424-433, Dec 1900
And R. Wood, "The Photography of Sound-Waves and the Demonstration of the Evolutions of Reflected Wave-Fronts with the Cinematograph," *Nature* **62**, 342–349 (1900). https://doi.org/10.1038/062342a0
[59] R. Wood, "The Photography of Sound-Waves and the Demonstration of the Evolutions of Reflected Wave-Fronts with the Cinematograph," *Nature* **62**, 342–349 (1900). https://doi.org/10.1038/062342a0
[60] Wood, "The Photography of Sound-Waves," 342.

Taking this series of photographs and then using those photographs to track how waves propagate, Wood's work demonstrated how foundational sound was in understanding optics. Materially, visually, and ideologically linked, sound and light were used to reinforce each other. While an entirely different process to Watts-Hughes, both Wood and Watts-Hughes used a material and mechanical means to visualize sound. For Watts-Hughes's *Voice Figures* it is in the actual process of getting invisible thing onto the plate, and for Wood, it is in how both behave, in substituting one for the other. If we understand that light and sound were indistinguishable from each other, we can see how the *Voice Figures* could become photographs, as registrations of sound they become registrations of its physical counterpart: light.

The wave-like movement and qualities of light and sound predate the painterly synesthesia, and ultimate abstraction, of Wassily Kandinsky's works. Heralded as the first abstract painter in histories of Western modern art, Kandinsky's unification of music and art became a catalyst for the breaking with figural representation. The work of Watts-Hughes, her type of artistic synesthesia, and the conflation between light and sound offer a curious pre-history of abstraction as her works attempt to, but ultimately rebuff figuration. Including her works in this history allows a place for technical registration, photography, and sound recording in histories of modern art and abstraction. And she has always been present. As a compliment to his synesthesia, Kandinsky turned to Theosophist thinkers and texts like the 1905 Annie Besant and C.W. Leadbeater's *Thought-Forms* which described and illustrated the ways that different kinds of thoughts could be represented.[61] Besant and Leadbeater cite Watts-Hughes's work on

[61] Mike King, "Concerning the Spiritual In Twentieth-century Art and Science." *Leonardo*, vol. 31, no. 1, 1 Feb. 1998, pp. 24 , doi.org/10.2307/1576543.

the human voice, writing that, “her work on the subject should be in the hands of every student.”[62]

Conclusion:

From the beginning acoustic media has shared language and goals with photography, but now, for a sonic artifact to be described as “photographic” shifts how we can define the medium. At the turn of the century, photography was not exclusively a light-based medium but a vibrational or wave-based one. Through the work of Watts-Hughes, we can begin to unpick the assumptions built into European and American histories of photography and sound recording, in optics and acoustics, including beliefs of one-to-one mimesis and neutral, technological objectivity.[63] In the *Voice Figures,* photographs are constructed objects that *sound*, that register clamor and silence as well as represent a picture-plane into the world.[64] Although not meant to be replayed as sound, understanding that these are material objects that contain noise is inherent to understanding them as images and as “photographs.” When histories of photography focus exclusively on the *photos*, or light, of photography, key aspects of its identity and potential are missed, including its early ties to acoustics and sound. Shifting focus from photography’s optics to its sonics through its past uncertainty allows us to explore the ways that this medium can be considered beyond the visual and into the aural, extending its possibilities beyond just “looking.”[65]

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[62] Annie Besant and C.W. Leadbeater, *Thought-Forms*, London: The Theosophical Publishing Society, 1905, 28.
[63] In this kind of project, I join scholarship that questions European photographic frameworks, looking to overturn narratives that focus on photography’s transparency, light, and reproduction. See Siobhan Angus, *Camera Geologica: An Elemental History of Photography* (Duke University Press, 2024). Giulia Paoletti, *Portrait and Place: Photography In Senegal, 1840-1960* (Princeton University Press, 2024).
[64] For a framework on objects that “sound” see Michael Gaudio, *Sound, Image, Silence: Art and the Aural Imagination In the Atlantic World* (University of Minnesota Press, 2019).
[65] On watching compared to looking see Ariella Azoulay, *The Civil Contract of Photography* (Zone Books, 2008), 16. For listening/feeling vibrational “hum” compared to looking see Campt, *Listening to Images*.

The implications of the *Voice Figures* being photographs unites histories of photography and sound recording, optics and acoustics. Light and sound at the turn of the century have much more in common than I think we realize now, and my hope is that these connections can set the conditions for rethinking art and technology, and the limitations placed on these categories. Working across art, science, music, photography, and sound recording technology, Watts-Hughes's work demonstrates the messiness of a period supposedly already having begun to be hyper-disciplined. Placing these histories together, especially placing sound's relation to vision for art history, presents new connections between the senses and for understanding visual culture of the period, especially for abstract and modern art. Understanding sound visually means it was understood scientifically, artistically, and aesthetically and therefore had resounding ramifications for the visual arts.