UNIVERSITY OF CALIFORNIA SAN DIEGO

Crossmodal Correspondences in Collaborative Audiovisual Performance

A Dissertation submitted in partial satisfaction of the requirements
for the degree Doctor of Musical Arts

in

Contemporary Music Performance

by

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The Dissertation of Ilana Waniuk is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

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DEDICATION

This document is dedicated to my parents Edgar and Silvana Waniuk and to my partner Joseph Bourdeau.

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ABSTRACT OF THE DISSERTATION

Crossmodal Perception in Collaborative Audiovisual Practices

by

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Doctor of Musical Arts in Contemporary Music Performance

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Considering the breadth of contemporary audiovisual performance practices, there is relatively little discourse examining audiovisual performance from a cross-modal sensory perspective. Most research tends to be framed in terms of sound or visuals. In this document, I undertake a discussion of multisensory perception and audiovisual performance by providing an overview of current research in synesthesia and crossmodal correspondences through the lens of experimental psychology. My investigation situates contemporary visualist Akiko Nakayama, within relevant audiovisual performance histories. Using material gathered from interviewing her

about her artistic practice, I provide insight into her embodied understanding of crossmodal correspondences in a performance setting. I also examine crossmodal perception in my own work as an emerging audiovisual practitioner by discussing recent examples —*Within Worlds,* Epistolary *Transmissions*, *Ember*, *Live Audiovisual Performance*, and *Archive*. Grounded in collaboration, the aforementioned projects blur boundaries between composition, performance and improvisation through the use of graphic scores with modular components, live audiovisual improvisation and hybrid work which blends aspects of both.

INTRODUCTION

Collaborative audiovisual performance encompasses a wide range of genres merging sound and image. Notwithstanding differences in lineages, materials and practices, audiovisual performance is rooted in improvisation, ephemerality and an unspoken understanding that its practice is a singular multi-disciplinary, ergo multi-sensory occurrence. For much of western human history, with the notable exception of synesthesia, perception was thought to be modular; a product of distinct modalities functioning autonomously (e.g., sight, hearing, touch). Recent developments in behavioral and brain imaging studies have challenged this hypothesis, suggesting that cross-modal sensory interactions are more ubiquitous than they were previously considered to be.

Considering the breadth of contemporary AV performance practices (live cinema, visual music, VJing, expanded cinema, etc.) there is relatively little discourse examining audiovisual performance from a cross-modal sensory perspective. Most research tends to be framed in terms of sound or visuals. In this document, I investigate cross-modal perception in collaborative audiovisual practices by situating contemporary artist Akiko Nakayama, within relevant audiovisual histories and using material gathered from interviewing her about her practice and embodied understanding of crossmodal correspondences in a performance setting. I will also examine cross-modal perception within my own practice as an emerging collaborative audiovisual practitioner through discussing recent examples of my own work—*Within Worlds,* Epistolary *Transmissions*, *Ember*, *Live Audiovisual Performance*, *Archive*—that fall broadly into three categories: graphic scores with modular components; experiments in collaborative live audiovisual improvisation; hybrid work which blends aspects of both. Contemporary audiovisual performance is typically reliant on digital technology as a tool to facilitate collaborative

improvisation. Reflecting my experience as a musician who interfaces primarily with acoustic instruments as a vehicle for co-creation, the artist I have chosen to interview uses modes of audiovisual performance that foreground analog processes and materials mediated by digital technologies.

Chapter 1: "Are we all synesthetes now?" provides an overview of synesthesia and crossmodal correspondences, drawing on research from the field of experimental psychology. My discussion is primarily focused on multisensory connections between vision and sound—though I do touch on other modalities tangentially through my overview (e.g. haptic, olfactory). Following an introduction to synesthesia and crossmodal correspondences, I examine similarities and differences between them in an attempt to find answers to the question: Are we all synesthetes now? To borrow a term from popular music, my question itself is a riff on the ongoing debate between researchers who consider synesthesia to be a continuum — see Jonathan Cohen's article: " "Synesthetic Perception as Continuous with Ordinary Perception, or: We're All Synesthetes Now"—and those who believe it to be distinct from other multisensory processes — as per Deroy and Spence's countering argument "Why We Are Not All Synesthetes (Not Even Weakly So)."[1] In order to frame the various lineages of collaborative audiovisual improvisation practices that I will introduce in Chapter 2 as well as those which resonate with my own artistic practice, the second half of the chapter will examine two prevalent facets of audiovisual crossmodal correspondences and synesthesia —color-tone correspondences and shape/sound correspondences— with respect to selected histories in music and visual arts from the first half

[1] Jonathan Cohen, "Synesthetic Perception as Continuous with Ordinary Perception, or: We're All Synesthetes Now," in *Sensory Blending: On Synaesthesia and Related Phenomena*, ed. Ophelia Deroy (Oxford University Press, 2017), 0, https://doi.org/10.1093/oso/9780199688289.003.0004; Ophelia Deroy and Charles Spence, "Why We Are Not All Synesthetes (Not Even Weakly So)," *Psychonomic Bulletin & Review* 20, no. 4 (August 1, 2013): 643–64, https://doi.org/10.3758/s13423-013-0387-2.

of the 20th century. I conclude by addressing some examples of crossmodal correspondences in my own work through a discussion of graphic notation, audiovisual improvisation, fixed audiovisual media, and staging in *Within Worlds* (2022) for flute, violin, live electronics and fixed audiovisual media.

Chapter 2: "Interview", introduces the work of Japanese visualist, Akiko Nakayama. Nakayama has developed a method of improvising with liquids that she calls "Alive Painting". Nakayama's use of liquids is informed by her interest in science, in particular fluid dynamics and biology. She believes that: "Life has different wavelengths. So, I create work of art with various materials and forms of media to capture each passing moments. I'm interested in the beauty of the boundary between two colors. To me, the meeting of two colors represents the dance of Yin and Yang."[2] I frame her artistic work with reference to the history of improvisatory liquid visuals which first emerged as a practice in San Francisco in the 1950's. Artists like Seymore Locks, and his students Elias Romero and Chet Helms, began experimenting with "swirling colored liquids in a dish and casting the "painting" on a wall by means of an overhead projector."[3] These experiments were typically accompanied by live music, usually jazz and would pave the way for the Light Shows of the 1960's. Crews of artists working together began to expand the artform to include other forms of projection (e.g. film, lumia, slides, animation, and various handmade devices). In contrast Nakayama's practice is relatively self-sufficient and relies less on the medium of light and more on the viscosity and various physical properties of the liquids themselves. The chapter concludes with an interview I conducted with Nakayama in which I

[2] Nakayama Akiko, "Statement," website, accessed August 12, 2024, https://www.akikopainting.com/statement.

[3] Kerry Brougher, "Visual-Music Culture," in *Visual Music*, ed. Jane Hyun and Elizabeth Hamilton, 2005, 159.

discuss her influences, artistic trajectory and embodied understanding of crossmodal perception in her work.

In Chapter 3: "Twilight Experiences", I undertake a close reading of several recent examples from my creative practice through the lens of audiovisual crossmodal correspondences introduced in Chapter 1—*Epistolary Transmissions* (2021), *Ember* (2021), *Live Audiovisual Practice/Performance*, *Archive* (ongoing). Grounded in collaboration, the aforementioned projects blur boundaries between composition, performance and improvisation through the use of graphic scores with modular components, live audiovisual improvisation and hybrid work which blends aspects of both. "Twilight Experiences" derives its name from Cornelius Cardew's description of a realm between notation and music making—a reference to the liminal space that the examples I've chosen traverse.[4] I begin the chapter with a brief discussion of Lydia Goehr's musical work-concept and the impact that hegemonic categorizations of musical roles (e.g. performer, composer) have had on my creative life as a classically trained performer.[5] My response has been to center configurability and creative agency as fundamental themes in my practice. As such, I felt it was salient to undertake a brief introduction to three graphic scores from the mid 20th century that were influential in first introducing me to the concept of indeterminacy and graphic notation with modular components: John Cage's *Fontana Mix* (1958) and George Brecht's *Water Yam* (c. 1963) and Cornelius Cardew's *Treatise* (1967). Even though these works were created over 60 years ago— and have become canonical in their own

[4] "The Treatise is almost like a document or movie of that sphere-a travelogue of the land of composition. A real piece of music of course is not a document from the sphere of activity in which music is written, it is 'just' a piece of music, which all lovers of music can understand. Treatise tells what it is like to manipulate sounds in composition. Sounds-ideas; reading Treatise is a twilight experience where the two cannot be clearly distinguished." Cornelius Cardew, *Treatise Handbook: Including Bun No. 2 [and] Volo Solo , Cornelius Cardew.*, Edition Peters ; Nr. 07129 (London ; Edition Peters, 1971), vii.

[5] Lydia Goehr, *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music , Lydia Goehr.* (Oxford, England: Clarendon Press, 1992).

right—my acquaintance with them represents a meaningful shift in my artistic perspective away from my formative classical training and towards new possibilities of music making.

Chapter 1 ARE WE ALL SYNESTHETES NOW?

Part 1: Synesthesia and Crossmodality

1.1 Synesthesia

Synesthesia has captured the imagination of scientists and artists since the late 19th century. To date, over 100 different variants in synesthetic experiences have been either reported, studied or discussed within scientific literature.[6] Typically, synesthesia is triggered in one sense by an 'inducer' (e.g. sound, touch, taste) which results in an involuntary reaction in an 'unstimulated' sense, known as the concurrent.[7] Leading researchers in the field of multisensory perception and synesthesia, neuroscientist Vilayanur S. Ramachandran and psychologist David Brang define synesthesia as "...an automatic and involuntary phenomenon in which one [sensory] modality evokes activation in a second, typically unrelated sensory or cognitive modality, resulting in the experience of atypical qualia."[8] Key characteristics thought to set synesthetes apart from non-synesthetes are that synesthesia presents as a multivariant condition with internal consistency in terms of the involuntary synesthetic response(s) sustained by each synesthetic individual (e.g. two people with tone-color synesthesia will independently experience their own unique set of internally consistent color to pitch correspondences).[9]

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[6] Jamie Ward and Julia Simner, "Synesthesia: The Current State of the Field," in *Multisensory Perception*, ed. K. Sathian and V. S. Ramachandran (Academic Press, 2020), 284, https://doi.org/10.1016/B978-0-12-812492-5.00013-9.

[7] Caroline Curwen, "Music-Colour Synaesthesia: Concept, Context and Qualia," *Consciousness and Cognition* 61 (May 2018): 94, https://doi.org/10.1016/j.concog.2018.04.005.

[8] David Brang and Vilayanur S. Ramachandran, "How Do Crossmodal Correspondences and Multisensory Processes Relate to Synesthesia?," in *Multisensory Perception: From Laboratory to Clinic*, ed. K. Sathian and V. S. Ramachandran (London: Academic Press, 2020), 259, https://doi.org/10.1016/B978-0-12-812492-5.00012-7. Curwen defines qualia as a "term used to describe the qualities of subjective experience associated with certain sensory stimuli…such as the difference between seeing a red rose and yellow rose or, in musical terms, the difference between a melody played on a piano and the same melody played on a French horn." Curwen, "Music-Colour Synaesthesia," 101.

[9] Ward and Simner, 284.

Synesthesia can encompass a wide range of sensory inducers and concurrents such as smell, taste, sight, touch, and hearing. Triggers are frequently external but can also arise from bodily sensations such as pain.[10] While synesthesia is often thought to be primarily a sensory phenomenon, inducers can present as non-sensory triggers or conceptual stimuli (e.g. some synesthetes see colors in response to spatial layouts like calendars).[11] Synesthetes can also experience non-sensory concurrents such as personality traits or emotions (e.g. sequence-personality synesthesia where ordered sequences such as the days of the week or letters of the alphabet engender personification).[12]

Scientists estimate that synesthesia affects between 2-4% of the population,[13] though the real number could be significantly higher given studies have yet to develop a comprehensive and reliable method of screening for the wide variety of ways that synesthesia can manifest. The most frequently studied and commonly documented forms of synesthesia are grapheme-color synesthesia and sound-color synesthesia or chromesthesia. In grapheme-color synesthesia, colorless numbers or letters (graphemes) function as inducers for color, while synesthetes with various forms of sound-color synesthesia experience color in response to sound.

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[10] George J. Dudycha and Martha M. Dudycha, "A Case of Synesthesia: Visual Pain and Visual Audition.," *The Journal of Abnormal and Social Psychology* 30, no. 1 (April 1935): 57–69, https://doi.org/10.1037/h0060678; Lawrence E. Marks, "Synesthesia, Then and Now," in *Sensory Blending: On Synaesthesia and Related Phenomena*, ed. Ophelia Deroy (Oxford University Press, 2017), 25, https://doi.org/10.1093/oso/9780199688289.003.0002.

[11] Ward and Simner, 285.

[12] Daniel Smilek et al., "When '3' Is a Jerk and 'E' Is a King: Personifying Inanimate Objects in Synesthesia," *Journal of Cognitive Neuroscience* 19, no. 6 (June 1, 2007): 981–92, https://doi.org/10.1162/jocn.2007.19.6.981; Marks, "Synesthesia, Then and Now," 21.

[13] Julia Simner et al., "Synaesthesia: The Prevalence of Atypical Cross-Modal Experiences," *Perception* 35, no. 8 (August 2006): 1029, https://doi.org/10.1068/p5469.

Tests to determine synesthesia are typically structured around measuring the consistency of responses to stimuli (e.g. Battery, “consistency test/test for genuineness”).[14] While consistency does appear to be a reliable method for identifying a particular kind of synesthete (e.g. certain types of grapheme-color or tone-color synesthetes), some researchers (Ward and Simner, Curwen) caution that relying solely on consistency as a qualifier runs the risk of eliminating other categories of synesthesia which present as context dependent, induce singular higher order sensory concurrents that are challenging to quantify (e.g. patterns, moving images, personality traits, non-veridical colors) or develop over long periods of time. Another inherent difficulty is that synesthetes experience cross-sensory activation unconsciously, and as such don't necessarily realize that their perceptual experiences are uncommon. Ward and Simmer go so far as to describe synesthesia as, "a benign alternative form of perception."[15]

1.2 Causes of Synesthesia

Despite over 200 years of research, the underlying biological/neurological systems responsible for synesthesia remain elusive. Some researchers speculate that anomalous neurological mechanisms are responsible for synesthesia, others posit that synesthesia is one end

[14] Curwen, 96. The Battery is a test used to 'verify' synesthetes. It has been particularly successful identifying subjects with grapheme-color synesthesia but has also been used to identify those with chromesthesia. It consists of a questionnaire to determine the kind of synesthesia present in the subject followed by a correspondingly specific online test (software). In the case of sound-color/chromesthesia, the test consists of an inducer in the form of either a single chord or sound file of a particular musical instrument and offers subjects the chance to choose from a spectrum of 16.7 million colors as a possible concurrent. Subjects are exposed to each inducer 3 times during the trial. Subjects who score less than 1 in terms of total color variation are considered to be synesthetes with non-synesthetes typically scoring 2 or higher; Ward and Simner, 286. “Test of Genuineness” involves presenting potentially synesthetic individuals with a list of triggering stimuli to gauge their responses. The same subjects are retested in a surprise retest at later interval, traditionally given weeks, months or years later depending on the scope and resources of the study (e.g. potential grapheme-color synesthetes are tested to measure the consistency of the color they associate with a particular number over time). Typically, only subjects who exhibit(ed) consistency are considered to be synesthetes.

[15] Ward and Simner, 283.

of a continuum that includes normal cross-modal sensory perception of non-synesthetes on the other. To date, research has not been able to prove connections between acquired synesthesia and those with a genetic predisposition. Brang and Ramachandran cite evidence of synesthesia-like experiences triggered by hallucinogens and amputees experiencing touch sensations in a phantom limb by observing touch in another—reminiscent of mirror-touch synesthesia—to hypothesize that the as yet unknown neural mechanisms responsible for synesthesia, could be present but suppressed or dormant in the general population.[16]

A substantial body of research suggests that genetics could play an important role in some types of synesthesia. Although the reasons for synesthesia's genetic preservation within the population are yet unknown, studies indicate that 40% of self-identified synesthetes report having an immediate family member with the condition.[17] The form synesthesia takes seems to vary within families suggesting that the genetic component of the condition could be more reflective of a "predisposition to synesthesia but not its expression."[18]

[16] David Brang and V. S. Ramachandran, "Survival of the Synesthesia Gene: Why Do People Hear Colors and Taste Words?," *PLOS Biology* 9, no. 11 (November 22, 2011): 3, https://doi.org/10.1371/journal.pbio.1001205.; Ward and Banissy define mirror-touch synesthesia (MTS) as "the conscious experience of tactile sensations induced by seeing someone else touched." Jamie Ward and Michael J Banissy, "Explaining Mirror-Touch Synesthesia," *Cognitive Neuroscience* 6, no. 2–3 (July 3, 2015): 118, https://doi.org/10.1080/17588928.2015.1042444.

[17] Brang and Ramachandran, "Survival of the Synesthesia Gene," 1; Kylie J. Barnett et al., "Familial Patterns and the Origins of Individual Differences in Synaesthesia," *Cognition* 106, no. 2 (February 2008): 871–93, https://doi.org/10.1016/j.cognition.2007.05.003; S. Baron-Cohen et al., "Synaesthesia: Prevalence and Familiality," *Perception* 25, no. 9 (1996): 1073–79, https://doi.org/10.1068/p251073.

[18] Brang and Ramachandran, "Survival of the Synesthesia Gene," 2.

1.3 Chromesthesia and Sound-color Synesthesia

> When I listen to music, I see the shapes on an externalized area about 12 inches in front of my face and about one foot high onto which the music is visually projected. Sounds are most easily likened to oscilloscope configurations—lines moving in color, often metallic with height, width and, most importantly, depth. My favorite music has lines that extend horizontally beyond the "screen" area.
>
> Deni Simon, *Wednesday is Indigo Blue*

Research has uncovered that there are two primary ways that synesthetes perceive colors: "projectors" who experience visuals as externally projected photisms—see synesthete Deni Simon's testimony above as recounted to Cytowic, Eagleman and Nabokov[19] —and "associators" who experience the concurrent as presenting in their mind's eye.[20] Historically, the most frequently studied form of chromesthesia is tone-color synesthesia, a subcategory of sound-color synesthesia, in which discrete tones or chords induce color(s). While studies of tone-color synesthesia have provided insight into possible neurological underpinnings of this particular synesthetic phenomenon (proximity between parts of the brain), in order to gain a deeper understanding of the chromesthetic experience, it is important to remember that music isn't

[19] Related to the term photopsia: "visual sensations in the absence of external visual stimuli," the APA Dictionary of Psychology defines a photism as: "a false perception or hallucination of light." Photisms can also be used to specifically refer to the synesthetic experience of perceiving light or color in response to various stimuli in non-visual sensory modalities (e.g. stimulation that is not the result of light waves)."APA Dictionary of Psychology," accessed August 1, 2024, https://dictionary.apa.org/photism.; "APA Dictionary of Psychology," accessed August 1, 2024, https://dictionary.apa.org/photopsia.; Richard E. Cytowic, David M. Eagleman, and Dmitri Nabokov, *Wednesday Is Indigo Blue: Discovering the Brain of Synesthesia* (Cambridge, UNITED STATES: MIT Press, 2009), 14, http://ebookcentral.proquest.com/lib/ucsd/detail.action?docID=3338997.

[20] Julia Simner and Emma Holenstein, "Ordinal Linguistic Personification as a Variant of Synesthesia," *Journal of Cognitive Neuroscience* 19, no. 4 (April 1, 2007): 694, https://doi.org/10.1162/jocn.2007.19.4.694.

typically heard as tones in isolation and is dependent on a variety of factors such as timbre, tempo, style, form and emotion.[21]

Concurrents brought about by sound-color synesthesia can extend to textures, shapes and landscapes,[22] and have been observed to be affected by timbre, volume, tempo, genre and emotional content in addition to frequency.[23] Chromesthesia can also be induced by higher order concepts such as key signatures, musical notation and the stylistic characteristics of specific composers.[24] Russian composer and synesthete Alexander Scriabin is reported to have experienced automatic color associations with key signatures so vividly, that he was upset by Richard Wagner's apparent insensitivity to the phenomenon as evidenced by Wagner's "inconsistency in changing keys" in the Ring Cycle.[25]

Synesthetes typically experience several forms of color-sound synesthesia simultaneously. In Mills, Boteler and Larrcombe's study, participant GS—an associator who experiences photisms "inside the back of her head" —describes her synesthetic experience of listening to music as being similar to having a "weird, psychedelic movie" play out in her mind.[26] For GS, different genres of music elicited responses with specific visual characteristics.

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[21] Caroline Curwen, "The Role of Synaesthesia in Reading Written Musical Key Signatures," *Journal of Experimental Psychology: General* 151, no. 10 (2022): 390, https://doi.org/10.1037/xge0001193.

[22] David M. Eagleman and Melvyn A. Goodale, "Why Color Synesthesia Involves More than Color," *Trends in Cognitive Sciences* 13, no. 7 (July 1, 2009): 288–92, https://doi.org/10.1016/j.tics.2009.03.009.

[23] Carol Bergfeld Mills, Edith Howell Boteler, and Glenda K Larcombe, "'Seeing Things in My Head': A Synesthete's Images for Music and Notes," *Perception* 32, no. 11 (November 1, 2003): 1359–76, https://doi.org/10.1068/p5100.

[24] Curwen, "The Role of Synaesthesia in Reading Written Musical Key Signatures"; Jamie Ward, Elias Tsakanikos, and Alice Bray, "Synaesthesia for Reading and Playing Musical Notes," *Neurocase* 12, no. 1 (February 2006): 27–34, https://doi.org/10.1080/13554790500473672.

[25] Ralph E. Matlaw, "Scriabin and Russian Symbolism," *Comparative Literature* 31, no. 1 (1979): 10, https://doi.org/10.2307/1770938.

[26] Mills, Boteler, and Larcombe, "'Seeing Things in My Head,'" 1361.

For example Romantic era music was reminiscent of Impressionist paintings with “watery-thick and dense colors," while heavy metal resulted in “big blocks of dark colors.”[27]

Cytowic, Eagleman and Nabokov, claim that synesthetes with chromesthesia typically experience comparatively simple visual, non-representational imagery such as colored shapes, lines, textures and/or patterns that appear and disappear over time.[28] Another distinguishing feature is that synesthetes experience visuals unidirectionally (e.g. for a tone-color synesthete, the pitch A might induce the color red, but not the reverse).

Some studies have shown that in comparison to controls, there appears to be a higher number of artists who experience synesthesia, particularly chromesthesia or grapheme-color synesthesia, however research has not yet provided any conclusive evidence to support a connection between clinical synesthesia and creativity. [29]

1.4 Crossmodal Perception

> What is essential in the sensuous-perceptible is not that which separates the senses from one another, but that which unites them; unites them among themselves; unites them with the entire (even with the non-sensuous) experience in ourselves; and with all the external world that there is to be experienced.
>
> Von Hornbostel, *The Unity of the Senses*[30]

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[27] Mills, Boteler, and Larcombe, 1361.

[28] Cytowic, Eagleman, and Nabokov, *Wednesday Is Indigo Blue*, 14.

[29] Stephen E. Palmer et al., “Music–Color Associations Are Mediated by Emotion,” *Proceedings of the National Academy of Sciences* 110, no. 22 (May 28, 2013): 8836–41, https://doi.org/10.1073/pnas.1212562110.; Brang and Ramachandran, “Survival of the Synesthesia Gene,” 3.

[30] Kosuke Motoki, Lawrence E. Marks, and Carlos Velasco, “Reflections on Cross-Modal Correspondences: Current Understanding and Issues for Future Research,” *Multisensory Research* 37, no. 1 (November 10, 2023): 2–3, https://doi.org/10.1163/22134808-bja10114; Brang and Ramachandran, “Survival of the Synesthesia Gene,” 3. Erich Moritz von Hornbostel (1877-1935), who originated the expression “unity of the senses” in 1927 was one of the earliest psychologists to undertake research connecting “brightness” with multiple sensory modalities.

Traditionally, classical studies of perception in the Western world considered sensory modalities to be distinct and to function in isolation from each other. Categorized according to the physical sensation that they were thought to be most receptive to (e.g. light for vision, sound for hearing), humans are generally thought to have five senses: touch, taste, hearing, smell and sight.[31] Humans and other species make sense of the overwhelming variety of stimuli we encounter daily by deriving information from multisensory cues that result in the simultaneous stimulation of multiple sensory modalities (e.g. the size and weight of an object can be determined through visual, haptic and aural cues). To interpret and sort the sensory information for a given environment, redundant and complementary sensory information is first processed independently via sensory specific systems and ultimately integrated into a coherent percept.[32] Building on a renewed interest in multisensory perception in the 20th century, a substantial body of research from a variety of fields (psychology, neuroscience, music, art, environmental design, etc.) indicates that both humans and animals regularly rely on interactions between sensory modalities (e.g. crossmodal correspondences) in order to make sense of the world around us.[33]

[31] Paul Bertelson and Béatrice de Gelder, "The Psychology of Multimodal Perception," in *Crossmodal Space and Crossmodal Attention*, ed. Charles Spence and Jon Driver (Oxford University Press, 2004), 141.

[32] Yuka Ohtake, Kanji Tanaka, and Kentaro Yamamoto, "How Many Categories Are There in Crossmodal Correspondences? A Study Based on Exploratory Factor Analysis," *PLOS ONE* 18, no. 11 (November 14, 2023): 1, https://doi.org/10.1371/journal.pone.0294141; Charles Spence, "Crossmodal Correspondences: A Tutorial Review," *Attention, Perception, & Psychophysics* 73, no. 4 (2011): 971, https://doi.org/10.3758/s13414-010-0073-7; "APA Dictionary of Psychology," American Psychological Association, accessed July 30, 2024, https://dictionary.apa.org/percept. The APA Dictionary of Psychology defines percept as "the product of perception: the stimulus object or event as experienced by the individual."

[33] Bertelson and de Gelder, "The Psychology of Multimodal Perception," 141–42.

1.5 Crossmodal Correspondences

Cross-modal correspondences are categorized as a "tendency for a feature attribute, dimension, or stimulus in one sensory modality, either physically present or merely imagined, to be matched (or associated) with a feature attribute, dimension, or stimulus in another modality."[34] In crossmodal correspondences, sensory dimensions (e.g. quantity and quality) and/or sensory features (e.g. pitch, saturation, piece of music) originating from different sensory modalities "correspond" to each other and are commonly experienced across a range of sensory modalities (e.g. touch, smell, taste, vision).[35] Researchers consider that many crossmodal correspondences are common to a large percentage of the population and in some cases are thought to be universal (see section 1.7 of this paper).[36]

Crossmodal correspondences have been studied using a wide array of nomenclatures: synesthetic correspondences, synesthetic associations, cross-sensory correspondences, crossmodal equivalences, crossmodal similarities, and natural crossmodal mappings.[37] By and

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[34] Charles Spence and K. Sathian, "Audiovisual Crossmodal Correspondences: Behavioral Consequences and Neural Underpinnings," in *Multisensory Perception: From Labratory to Clinic*, ed. K. Sathian and V. S. Ramachandran (Academic Press, 2020), 239, https://doi.org/10.1016/B978-0-12-812492-5.00011-5; Spence, "Crossmodal Correspondences," 293. Spence defines stimulus as "an event or object."

[35] Motoki, Marks, and Velasco, 10; Ohtake, Tanaka, and Yamamoto, 1.

[36] Spence, 973.

[37] Peter Walker et al., "Preverbal Infants' Sensitivity to Synaesthetic Cross-Modality Correspondences," *Psychological Science* 21, no. 1 (January 2010): 21–25, https://doi.org/10.1177/0956797609354734.; Jeroen J. Stekelenburg and Mirjam Keetels, "The Effect of Synesthetic Associations between the Visual and Auditory Modalities on the Colavita Effect," *Experimental Brain Research* 234, no. 5 (May 2016): 1209–19, https://doi.org/10.1007/s00221-015-4363-0.; Laura Walker, Peter Walker, and Brian Francis, "A Common Scheme for Cross-Sensory Correspondences across Stimulus Domains," *Perception* 41, no. 10 (October 1, 2012): 1186–92, https://doi.org/10.1068/p7149.; David J Lewkowicz, Gerald Turkewitz, and Hunter College, "Cross-Modal Equivalence in Early Infancy: Auditory-Visual Intensity Matching," *Developmental Psychology* 16, no. 6 (1980): 597–607.; L. E. Marks, "On Cross-Modal Similarity: The Perceptual Structure of Pitch, Loudness, and Brightness," *Journal of Experimental Psychology. Human Perception and Performance* 15, no. 3 (August 1989): 586–602, https://doi.org/10.1037//0096-1523.15.3.586; K. K. Evans and A. Treisman, "Natural Cross-Modal Mappings between Visual and Auditory Features," *Journal of Vision* 10, no. 1 (January 6, 2011): 6–6, https://doi.org/10.1167/10.1.6.

large, synesthetic associations/equivalences relate to correspondences between seemingly nonredundant sensory modalities such as hearing and vision. Leading multisensory researcher and experimental psychologist Charles Spence, advocates for using the term "crossmodal correspondences" because it encompasses correspondences that are "synesthetic" as well as those that are redundantly coded.[38]

Crossmodal correspondences can range from low-level perceptual associations such as pitch-height and size, or pitch-height and spatial elevation, to more complex cognitive connections such as music and painting or music and taste.[39] On a more abstract level, crossmodal correspondences can be related to stimuli via positive valence or cognitive meaning.[40] In this case, the associated stimuli might elicit a similar mood or emotional state.[41]

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[38] Redundantly coded stimulus features refer to stimuli that can be perceived through multiple sensory modalities (e.g. size and shape).

[39] Leonardo Bonetti and Marco Costa, "Pitch-Verticality and Pitch-Size Cross-Modal Interactions," *Psychology of Music* 46, no. 3 (May 1, 2018): 340–56, https://doi.org/10.1177/0305735617710734; David B. Doty, *The Just Intonation Primer : An Introduction to the Theory and Practice of Just Intonation*, 2nd ed. (San Francisco, CA: Just intonation Network, 1994), 8. Pitch is measured in frequency of vibrations per second and is expressed in units of Hertz (Hz). One Hz being equal to one vibration per second. Any sound that creates the impression of one prevalent pitch-height is called a pitch and is the product of periodic vibrations repeating in a consistent pattern and rate. The greater the frequency of the vibrations, the higher the sounding pitch.; Cesare V. Parise, Katharina Knorre, and Marc O. Ernst, "Natural Auditory Scene Statistics Shapes Human Spatial Hearing," *Proceedings of the National Academy of Sciences* 111, no. 16 (April 22, 2014): 6104–8, https://doi.org/10.1073/pnas.1322705111.; Qian (Janice) Wang, Andy T. Woods, and Charles Spence, "'What's Your Taste in Music?' A Comparison of the Effectiveness of Various Soundscapes in Evoking Specific Tastes," *I-Perception* 6, no. 6 (December 1, 2015): 2041669515622001, https://doi.org/10.1177/2041669515622001; Liliana Albertazzi, Luisa Canal, and Rocco Micciolo, "Cross-Modal Associations between Materic Painting and Classical Spanish Music," *Frontiers in Psychology* 6 (2015): 424, https://doi.org/10.3389/fpsyg.2015.00424.; Motoki, Marks, and Velasco, "Reflections on Cross-Modal Correspondences," 11. When studying a more complex perceptual pairing such as music and color, one would need to determine which specific attributes of color (e.g. hue, brightness) would correspond with distinct musical characteristics (e.g. tempo, pitch, modality).

[40] Anne-sylvie Crisinel and Charles Spence, "As Bitter as a Trombone: Synesthetic Correspondences in Nonsynesthetes between Tastes/Flavors and Musical Notes," *Attention, Perception, & Psychophysics* 72, no. 7 (October 1, 2010): 1994–2002, https://doi.org/10.3758/APP.72.7.1994.

[41] Lewkowicz, Turkewitz, and College; Spence, "Crossmodal Correspondences," 973.

In general, crossmodal correspondences can involve absolute or relative equivalences between values or attributes in distinct sensory modalities (e.g. high auditory pitch and high visuo-spatial elevation) and can be applied to both qualitative perceptual attributes (e.g. hue or timbre) and quantitative such as size or duration.[42]

1.6 Categorizing Crossmodal Correspondences

There are many ways that stimuli can correspond across different sensory modalities. Drawing from my own experience, one of the most relevant crossmodal correspondences to collaborative audiovisual improvisation is amodality. Amodal features are thought to be shared by many, if not all, sensory modalities and can include duration, temporal patterning (rhythm) of events, shape and size, intensity, movement, and texture.[43] Crossmodal correspondences can also take place between modal and amodal stimulus features or between features in two or more sensory modalities such as the tendency to pair high pitched sounds with small bright objects.[44]

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[42] Motoki, Marks, and Velasco, 3–4.

[43] Sharon E. Guttman, Lee A. Gilroy, and Randolph Blake, "Hearing What the Eyes See: Auditory Encoding of Visual Temporal Sequences," *Psychological Science* 16, no. 3 (March 1, 2005): 228–35, https://doi.org/10.1111/j.0956-7976.2005.00808.x.; Charles Spence and Massimiliano Zampini, "Auditory Contributions to Multisensory Product Perception," *Acta Acustica United with Acustica* 92, no. 6 (November 1, 2006): 1009–25; Lawrence E Marks, Rosemary Szczesiul, and Patricia Ohlott, "On the Cross-Modal Perception of Intensity," *Journal of Experimental Psychology; Human Perception and Performance* 12, no. 4 (1986): 517–34; Salvador Soto-Faraco, Charles Spence, and Alan Kingstone, "Cross-Modal Dynamic Capture: Congruency Effects in the Perception of Motion Across Sensory Modalities.," *Journal of Experimental Psychology: Human Perception and Performance* 30, no. 2 (2004): 330–45, https://doi.org/10.1037/0096-1523.30.2.330; Vanalata Bulusu and Leslee Lazar, "Crossmodal Associations between Naturally Occurring Tactile and Sound Textures," *Perception* 53, no. 4 (April 1, 2024): 219–39, https://doi.org/10.1177/03010066231224557; Monika Imschloss and Christina Kuehnl, "Feel the Music! Exploring the Cross-Modal Correspondence between Music and Haptic Perceptions of Softness," *Journal of Retailing*, Sensory Aspects of Retailing, 95, no. 4 (December 1, 2019): 158–69, https://doi.org/10.1016/j.jretai.2019.10.004; Spence, "Crossmodal Correspondences," 973.

[44] Spence, 973. Modal features are aspects of a stimulus that are particular to a single sensory modality. Examples include the hue of light or the pitch of a sound.

Researchers have suggested that there are at least four distinctive qualitative categories of cross-modal correspondences with specific developmental pathways and behavioral outcomes; statistical, structural or physiological, semantic or lexical, and emotional or hedonic.[45] Statistical correspondences are learned cross-sensory mappings that are the result of frequent co-occurrence in a multisensory environment.[46] For example, the fact that larger objects tend to produce louder sounds.[47] Structural or physiological correspondences are the result of neural processing or connections between processing systems and as such are automatic rather than learned. Amodal correspondences such as magnitude or intensity are examples of crossmodal connections that are thought to be the result of neural coding.[48] Semantic or lexical correspondences are learned associations connected to linguistic consistency whereby the same term is used to refer to sensory dimensions in multiple modalities (e.g. "high" and "low" can be used to describe characteristics of pitch and elevation).[49] Emotionally mediated or hedonic correspondences pair similar emotions, moods or hedonic (positive/negative) valence to each component stimuli.[50]

Categories of crossmodal correspondences are primarily delineated according to how the crossmodal association is thought to be established (e.g. statistical learning, brain structure,

[45] Spence, "Crossmodal Correspondences"; Charles Spence, "Exploring Group Differences in the Crossmodal Correspondences," *Multisensory Research* 35, no. 6 (August 9, 2022): 495–536, https://doi.org/10.1163/22134808-bja10079; Motoki, Marks, and Velasco, "Reflections on Cross-Modal Correspondences."

[46] Brang and Ramachandran, "How Do Crossmodal Correspondences and Multisensory Processes Relate to Synesthesia?," 263.

[47] Sean W. Coward and Catherine J. Stevens, "Extracting Meaning from Sound: Nomic Mappings, Everyday Listening, and Perceiving Object Size from Frequency," *The Psychological Record* 54, no. 3 (July 1, 2004): 349–64, https://doi.org/10.1007/BF03395478.

[48] S S Stevens, "ON THE PSYCHOPHYSICAL LAW," *The Psychological Review* 64, no. 3 (1957); Spence, "Exploring Group Differences in the Crossmodal Correspondences," 496.

[49] Spence, "Exploring Group Differences in the Crossmodal Correspondences," 496.

[50] Spence, 496.

semantic or emotional links).[51] Semantic and statistic crossmodal correspondences are typically relative rather than absolute (e.g. size to pitch), requiring individuals to choose preferences according to a specific range.[52] For example, an individual might pair a small object with the highest pitch in a particular sequence while the same pitch in a different setting could be equated with an object of a different size.[53]

Since crossmodal correspondences often originate from multiple sources and the underlying mechanisms responsible aren't precisely understood, it can be difficult to determine which category a correspondence should be classified as—particularly since most research to date has been designed to investigate one category at a time.[54] In the case of pitch-elevation correspondences for example, not only does this pairing likely originate from statistical and semantic sources, but pitch and elevation have been shown to connote affective—ergo emotional— properties.[55]

[51] Brang and Ramachandran, "How Do Crossmodal Correspondences and Multisensory Processes Relate to Synesthesia?," 263.

[52] Alberto Gallace and Charles Spence, "Multisensory Synesthetic Interactions in the Speeded Classification of Visual Size," *Perception & Psychophysics* 68, no. 7 (October 1, 2006): 1191–1203, https://doi.org/10.3758/BF03193720.

[53] Brang and Ramachandran, "How Do Crossmodal Correspondences and Multisensory Processes Relate to Synesthesia?," 264.

[54] Ohtake, Tanaka, and Yamamoto, 3.

[55] The word 'high' can be applied to both space and location.; Michel Belyk and Steven Brown, "Perception of Affective and Linguistic Prosody: An ALE Meta-Analysis of Neuroimaging Studies," *Social Cognitive and Affective Neuroscience* 9, no. 9 (September 1, 2014): 1395–1403, https://doi.org/10.1093/scan/nst124; Motoki, Marks, and Velasco, "Reflections on Cross-Modal Correspondences," 8. In the case of pitch and elevation, both higher pitch and location can be corelated to a greater positive valence relative to the inverse.

1.7 Similarities and Differences in Crossmodal Correspondences

Correspondences such as pitch and size, pitch-elevation, and visual brightness to pitch are some examples of cross modal correspondences that are thought to be relatively universal due to the regularity of their occurrence and likelihood of exposure across cultures.[56] There is also compelling evidence to support strong cross-cultural and cross-linguistic similarities for certain sound-symbolic correspondences across a variety of languages. For example, shape-sound correspondences known as the 'bouba-kiki' effect—see section 1.8 for a more in-depth discussion—have been observed across a wide variety of cultures ranging from the Himba tribe of Kaokoland in Northern Namibia, as well as across the UK and Taiwan.[57]

Considering the prevalence of associative learning with regards to categories of crossmodal correspondences (emotional, semantic, structural), it follows that scientists have become increasingly interested in investigating the impact of cross-cultural differences in cross-

[56] Spence, "Exploring Group Differences in the Crossmodal Correspondences," 501; 508; 522. Spence reminds us that 'universal' does not necessarily equate to innate, pointing to a significant body of scientific literature suggesting that many cross-modal correspondences are acquired and develop over the course of childhood (see Smith and Sera, 1992; Marks et al,1987); Linda B Smith and Maria D Sera, "A Developmental Analysis of the Polar Structure of Dimensions," *Cognitive Psychology* 24, no. 1 (January 1992): 99–142, https://doi.org/10.1016/0010-0285(92)90004-L.; Lawrence E. Marks et al., "Perceiving Similarity and Comprehending Metaphor," *Monographs of the Society for Research in Child Development* 52, no. 1 (1987): i–100, https://doi.org/10.2307/1166084.

[57] Andrew J. Bremner et al., "'Bouba' and 'Kiki' in Namibia? A Remote Culture Make Similar Shape–Sound Matches, but Different Shape–Taste Matches to Westerners," *Cognition* 126, no. 2 (February 1, 2013): 165–72, https://doi.org/10.1016/j.cognition.2012.09.007.; Yi-Chuan Chen et al., "When 'Bouba' Equals 'Kiki': Cultural Commonalities and Cultural Differences in Sound-Shape Correspondences," *Scientific Reports* 6, no. 1 (May 27, 2016): 26681, https://doi.org/10.1038/srep26681; Bremner et al., "'Bouba' and 'Kiki' in Namibia?"; Spence, 505–6; 522.; Ćwiek et al. studied the bouba-kiki effect on "speakers from 25 different languages and nine different language families that use a total of 10 different scripts." Aleksandra Ćwiek et al., "The *Bouba/Kiki* Effect Is Robust across Cultures and Writing Systems," *Philosophical Transactions of the Royal Society B: Biological Sciences* 377, no. 1841 (January 3, 2022): 4, https://doi.org/10.1098/rstb.2020.0390.; Spence notes that exceptions include languages where pseudoword phonemes are absent or contradict phonotactic principles; S.K. Scott defines phonotactics as the way that "in different languages, different sequences of speech sounds are possible, and can also govern overall syllable structure. For example, in British English, a syllable can be formed with up to three consonants before a vowel, and up to four afterward (e.g., 'strengths'). Such a structure would be impossible in some other languages; for example, Japanese does not permit clusters of consonants before or after a vowel. Phonotactics thus describes properties of syllable structure at both local and global levels." S.K. Scott, "Speech Perception: Cortical Processing," in *Encyclopedia of Neuroscience* (Elsevier, 2009), 229, https://doi.org/10.1016/B978-008045046-9.01901-X.

modal correspondences.[58] For example, studies investigating audiovisual correspondences have found that musical training has been shown to impact audiovisual correspondences.[59] Another study investigating crossmodal correspondences between color-shape-texture-taste for participants from China, India, Malaysia and the U.S., noted clear similarities amongst participants of each nationality but also distinct differences from country to country.[60] Wan et al. concluded that in addition to factors like gender, cooking experience, and access to international travel, "cultural difference, differences in other domains, such as geographic locations, climates, agriculture, may also play an important role in the formation of crossmodal associations between taste/flavors and visual features."[61] Research has indicated that space-pitch associations are likely also influenced by language. For example, English, Dutch and German use high-low contrasts to convey pitch and elevation while "Farsi, Turkish, and Zapotec organize sound in a different way. Thin applies to high pitch and low amplitude and thick to low pitch and high amplitude."[62] Studying the effects of language on height-pitch and thickness-pitch correspondences in Dutch and Turkish speakers, Dolscheid at al. observed that Dutch speakers generally demonstrated a stronger height-pitch association than thickness-pitch, while Turkish speakers tended to exhibit the inverse, suggesting that language plays a significant role in

[58] Spence, "Exploring Group Differences in the Crossmodal Correspondences," 505.

[59] Robert Walker, "The Effects of Culture, Environment, Age, and Musical Training on Choices of Visual Metaphors for Sound," *Perception & Psychophysics* 42, no. 5 (September 1987): 491–502, https://doi.org/10.3758/BF03209757.

[60] Xiaoang Wan et al., "Cross-Cultural Differences in Crossmodal Correspondences between Basic Tastes and Visual Features," *Frontiers in Psychology* 5 (December 8, 2014), https://doi.org/10.3389/fpsyg.2014.01365.

[61] Wan et al., 10.

[62] Shakila Shayan, Ozge Ozturk, and Mark A. Sicoli, "The Thickness of Pitch: Crossmodal Metaphors in Farsi, Turkish, and Zapotec," *The Senses and Society* 6, no. 1 (March 1, 2011): 6, https://doi.org/10.2752/174589311X12893982233911.

forming space-pitch associations.[63] The aforementioned studies support Spence's hypothesis that cross-cultural variation is likely to occur for cross-modal correspondences that are statistical or learned in nature.[64]

When considering commonalities and differences in crossmodal correspondences it is important to remember that, irrespective of the handful of cross-cultural studies discussed above, most of the research in established crossmodal correspondence literature has historically drawn participants from primarily Western, industrialized, democratic countries, who are typically undergraduate students in psychology.[65] In order to gain a deeper understanding of cross-cultural similarities and differences and their impact on crossmodal correspondences, more care and effort needs to be directed towards designing future studies in order to reflect a range of intersectional identities, cultural experiences, and traditions.[66]

1.8 Audiovisual Crossmodal Correspondences: Sound-Symbolism, Music and The Emotional Mediation Hypothesis

To date, a substantial body of research has established crossmodal correspondences between basic auditory dimensions and other sensory modalities (e.g. visual, tactile, gustatory,

[63] Sarah Dolscheid et al., "Space-Pitch Associations Differ in Their Susceptibility to Language," *Cognition* 196 (March 1, 2020): 5, https://doi.org/10.1016/j.cognition.2019.104073.

[64] Spence, "Exploring Group Differences in the Crossmodal Correspondences," 507.

[65] Spence and Sathian, "Chapter 11 - Audiovisual Crossmodal Correspondences," 253.

[66] First coined by Kimberlé Crenshaw in 1989, intersectionality is: "a metaphor for understanding the ways that multiple forms of inequality or disadvantage sometimes compound themselves and create obstacles that often are not understood among conventional ways of thinking." In the case of crossmodal research, considering an intersectional approach—reflective of gender, race, sexuality or socioeconomic status for example—could help to provide valuable insight into the impact of learned and statistical correspondences in the wider context of contemporary society. Kimberlé Williams Crenshaw, "Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics," *University of Chicago Legal Forum* 1989, no. 1 (December 7, 2015): 149, https://chicagounbound.uchicago.edu/uclf/vol1989/iss1/8..

kinesthetic and olfactory).[67] However, by and large, audiovisual crossmodal correspondences have received the most robust study within the field of multisensory perception.[68] Research on audiovisual correspondences ranges from pairings between simple auditory characteristics such (e.g. pitch height -loudness or sounds-shapes), to correspondences between color, music and emotion, to higher-level complex correspondences such as those between music and painting.[69]

While crossmodal correspondence research has examined audiovisual relationships between relatively complex musical dimensions such as tempo, and timbre, most studies related to crossmodal correspondences involving sound have focused on basic auditory dimensions such as loudness and pitch height.[70] The prominence of pitch frequency and loudness in research is likely due to the fact that both can be measured along a bipolar axis—low/high, quiet/loud— and

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[67] Charles Spence and Ophelia Deroy, "On the Shapes of Flavours: A Review of Four Hypotheses," *Theoria et Historia Scientiarum* 10 (May 7, 2014): 207, https://doi.org/10.12775/ths-2013-0011; Shoko Kanaya, Kenji Kariya, and Waka Fujisaki, "Cross-Modal Correspondence Among Vision, Audition, and Touch in Natural Objects: An Investigation of the Perceptual Properties of Wood," *Perception* 45, no. 10 (October 1, 2016): 1099–1114, https://doi.org/10.1177/0301006616652018; Ophelia Deroy, Anne-Sylvie Crisinel, and Charles Spence, "Crossmodal Correspondences between Odors and Contingent Features: Odors, Musical Notes, and Geometrical Shapes," *Psychonomic Bulletin & Review* 20, no. 5 (October 2013): 878–96, https://doi.org/10.3758/s13423-013-0397-0; Beau Sievers et al., "Music and Movement Share a Dynamic Structure That Supports Universal Expressions of Emotion," *Proceedings of the National Academy of Sciences* 110, no. 1 (January 2, 2013): 70–75, https://doi.org/10.1073/pnas.1209023110.

[68] Spence and Sathian, 239.

[69] Spence and Sathian, 240. It should be acknowledged that pitch and hue crossmodal correspondences have also received a significant amount of attention in terms of theoretical, empirical, philosophical and artistic research. I will address this topic in more detail later in this document (1.11 Pitch-Color Correspondence and Color Organs) and limit the focus of the following section to introducing audiovisual crossmodal correspondence research regarding music, emotion and color, and sound-symbolism respectively.; Atara Isaacson, Amichay Assis, and Esther Adi-Japha, "'Listening' to Paintings: Synergetic Effect of a Cross-Modal Experience on Subjective Perception," *Empirical Studies of the Arts* 41, no. 2 (July 2023): 433–64, https://doi.org/10.1177/02762374231155742; Albertazzi, Canal, and Micciolo, "Cross-Modal Associations between Materic Painting and Classical Spanish Music."

[70] Mats B. Küssner et al., "Musicians Are More Consistent: Gestural Cross-Modal Mappings of Pitch, Loudness and Tempo in Real-Time," *Frontiers in Psychology* 5 (July 28, 2014), https://doi.org/10.3389/fpsyg.2014.00789.; Marco Pitteri et al., "Naturally Together: Pitch-Height and Brightness as Coupled Factors for Eliciting the SMARC Effect in Non-Musicians," *Psychological Research* 81, no. 1 (January 1, 2017): 243–54, https://doi.org/10.1007/s00426-015-0713-6. Other commonly researched crossmodal correspondences pairing simple characteristics of sound with other sensory modalities include; auditory loudness to visual brightness; auditory pitch and elevation; auditory pitch and object size; auditory pitch and object brightness (see Spence, "Crossmodal Correspondences" for a review).

as such can be easily paired with other sensory dimensions that can be measured along a comparable continuum (e.g. brightness, object size, spatial elevation).[71] Eitan notes that relatively little research has investigated music specific features in crossmodal correspondence (e.g. formal structure, harmony, melody, chord structure, rhythmic structure, tonality).[72] Even when music is used as a stimulus, the focus of researchers tends to foreground basic auditory dimensions rather than more complex musical ones.[73] In the realm of basic auditory dimensions, studies have established that high-pitched sounds are not only associated with higher spatial elevation, but are also reliably correlated with relative amodal characteristics (e.g. faster speed, smaller size, lightweight), and other sensory attributes such as sweet or sour tastes, cold temperatures, and hard, smooth textures.[74]

One of the earliest and frequently studied examples of audiovisual crossmodal correspondence is sound-symbolism: "Sound symbolism refers to the nonarbitrary mappings that exist between phonetic properties of speech sounds and their meaning."[75] In 1929, Edward Sapir observed that when asked to pair nonsense words "mal" and "mil" with a large or small object,

[71] Zohar Eitan, "Musical Connections: Cross-Modal Correspondences," in *The Routledge Companion to Music Cognition* (Routledge, 2017), 214.

[72] Eitan, 214.

[73] Spence defines complex auditory stimuli as "containing multiple individuable elements." Charles Spence, "Assessing the Role of Emotional Mediation in Explaining Crossmodal Correspondences Involving Musical Stimuli," *Multisensory Research* 33, no. 1 (July 1, 2020): 2, https://doi.org/10.1163/22134808-20191469.

[74] Eitan, "Musical Connections," 214. See Spence 2011;Walker 2016 for reviews. Spence, "Crossmodal Correspondences"; Peter Walker, "Cross-Sensory Correspondences: A Theoretical Framework and Their Relevance to Music.," *Psychomusicology: Music, Mind, and Brain* 26, no. 2 (2016): 103–16, https://doi.org/10.1037/pmu0000130.

[75] Spence and Sathian, 247.

students consistently associated the speech sounds /a/ with the larger and /i/ with the smaller.[76] In the same year, Wolfgang Köhler conducted an experiment asking participants to choose between pairing “baluma” and “takete” with either a rounded or an angular shape.[77] Participants overwhelmingly chose to pair “baluma” with the rounded shape and vice versa.[78] More recently Ramachandran and Hubbard conducted similar tests using "bouba/kiki”.[79] The bouba-kiki or kiki-bouba effect—as it has come to be known— demonstrated that individuals from a variety of cultural backgrounds commonly connect the rounder image on the left with “bouba” and the more angular shape on the right with “kiki” (see Figure 1.1).[80]

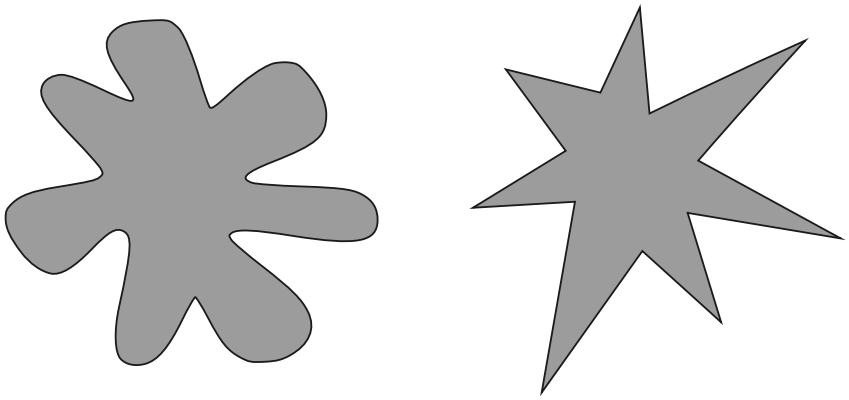

Figure 1.1: Example of Shapes used to test the bouba-kiki effect.

[76] E. Sapir, “A Study in Phonetic Symbolism.,” *Journal of Experimental Psychology* 12, no. 3 (June 1929): 225–39, https://doi.org/10.1037/h0070931.

[77] Wolfgang Köhler, *Gestalt Psychology*, Liveright (New York, 1929).

[78] Charles Spence and Mary Kim Ngo, “Assessing the Shape Symbolism of the Taste, Flavour, and Texture of Foods and Beverages,” *Flavour* 1, no. 1 (July 2, 2012): 3, https://doi.org/10.1186/2044-7248-1-12. In order to avoid the association between “baluma” and balloon, Kohler conducted a further series of experiments in 1947 yielding similar results with the variation “maluma/takete.”

[79] V S Ramachandran and E M Hubbard, “Synaesthesia — A Window Into Perception, Thought and Language,” *Journal of Consciousness Studies* 8, no. 12 (2001): 3–34; Vilayanur S. Ramachandran and Edward M. Hubbard, “Hearing Colors, Tasting Shapes,” *Scientific American* 288, no. 5 (2003): 52–59.

[80] Brang and Ramachandran, “How Do Crossmodal Correspondences and Multisensory Processes Relate to Synesthesia?,” 262–63.

Researchers hypothesize that sound-symbolism evidenced by the bouba-kiki effect could be the result of the temporal pattern of the sound in combination with the shape of the mouth when speaking: "The reason is that the sharp changes in visual direction of the lines in the right-hand figure [mimic] the sharp phonemic inflections of the sound kiki, as well as the sharp inflection of the tongue on the palate."[81] Contrastingly, "the gentle curves of the amoebalike figure metaphorically mimic the gentle undulations of the sound 'bouba' as represented in the hearing centers in the brain as well as the gradual inflection of the lips as they produce the curved 'boobaa' sound."[82] Recent research by Sidhu and Pexman (2018) has outlined five further mechanisms likely involved in the sound-symbolic associations involved in the bouba-kiki effect: high-front vowels and small shapes are linked to smallness; high volume and brightness correspond with high magnitude; stop consonants and angular shapes can suggest fast speed and high tension; high-front vowels are associated with thinness; sweet taste and round shapes exhibit positive hedonic values; vowels share semantic correspondences with brightness.[83]

In crossmodal correspondences, the emotional mediation hypothesis suggests that some crossmodal mappings, particularly those observed between musical and non-auditory features (e.g., color), tend to be paired together because both share a congruent emotional association—for example low pitches and dark colors can both be associated with a negative valence.[84] Palmer, Schloss, Xu and Prado-León explain further: "The emotional mediation hypothesis

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[81] Ramachandran and Hubbard, "Synaesthesia — A Window Into Perception, Thought and Language," 19.

[82] Ramachandran and Hubbard, "Hearing Colors, Tasting Shapes," 8.

[83] David M. Sidhu and Penny M. Pexman, "Five Mechanisms of Sound Symbolic Association," *Psychonomic Bulletin & Review* 25, no. 5 (October 1, 2018): 1631, https://doi.org/10.3758/s13423-017-1361-1.

[84] Eitan, "Musical Connections," 220.

suggests that, as people listen to the music, they have emotional responses while listening to music and then pick colors with similar emotional content."[85] Studies have shown that auditory features can connect to emotional responses through crossmodal correspondences (e.g. the association of a negative emotional valence with low pitch and volume), just as non-auditory dimensions that frequently map to pitch and volume, such as brightness and spatial elevation, can also be semantically associated with emotion (e.g. "dark" and "bright" or "high" and "low" moods). [86] Some commonalities that have been corroborated through multiple studies include; associating music in the major mode with lighter colors in comparison to music in the minor mode and equating faster tempi with brighter and comparatively more saturated colors.[87] The emotional mediation hypothesis has been used to demonstrate associations between music and color as well as between music and other sensory modalities such as music and smell and music and brightness.[88] Another important factor involved in studying the emotional mediation hypothesis is that since the concept of "emotion" is categorically challenging to define, studies investigating this theory invariably include contrasting definitions.[89]

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[85] Palmer et al., "Music–Color Associations Are Mediated by Emotion," 8838.

[86] William G. Collier and Timothy L. Hubbard, "Judgments of Happiness, Brightness, Speed and Tempo Change of Auditory Stimuli Varying in Pitch and Tempo.," *Psychomusicology: A Journal of Research in Music Cognition* 17, no. 1–2 (2001): 36–55, https://doi.org/10.1037/h0094060.; Eitan, "Musical Connections," 219.

[87] Palmer et al. 8838.

[88] Palmer et al.; Kelly L. Whiteford et al., "Color, Music, and Emotion: Bach to the Blues," *I-Perception* 9, no. 6 (November 1, 2018): 2041669518808535, https://doi.org/10.1177/2041669518808535; PerMagnus Lindborg and Anders K. Friberg, "Colour Association with Music Is Mediated by Emotion: Evidence from an Experiment Using a CIE Lab Interface and Interviews," *PloS One* 10, no. 12 (2015): e0144013, https://doi.org/10.1371/journal.pone.0144013.; Carmel A Levitan et al., "The Smell of Jazz: Crossmodal Correspondences Between Music, Odor, and Emotion," *CogSci* 1 (2015): 1326–31.; Joydeep Bhattacharya and Job P. Lindsen, "Music for a Brighter World: Brightness Judgment Bias by Musical Emotion," *PLoS ONE* 11, no. 2 (2016), https://doi.org/10.1371/journal.pone.0148959.

[89] Spence, "Assessing the Role of Emotional Mediation in Explaining Crossmodal Correspondences Involving Musical Stimuli," 17.

Regardless of genre, music is a dynamic network of interrelated auditory components (e.g. pitch, timbre, rhythm, melody, density, harmony). By extension, listening to music—whether through headphones, speakers, in the concert hall or club—is inherently a multilayered and highly individual process. Gabrielsson notes: "Music experience is a complex phenomenon and is influenced by a variety of interacting factors. Different individuals react differently, and reactions to the same music may vary on different occasions. Many people find it extremely difficult to describe their experience; it seems to elude common vocabulary."[90] Consequently, while emotional mediation might play an important role in forming crossmodal correspondences between music-color, other factors such as statistical and/or semantic correspondences, personal experiences, and cultural context, are likely equally as significant to the formation of crossmodal connections. For example, in Whiteford, Schloss, Helwig, and Palmer's study, many participants associated black and dark colors with heavy metal music and Irish music with greens.[91] A critical examination of the emotional mediation hypothesis reveals that studies researching correlations between music and emotion have been primarily limited to pre-recorded excerpts that privilege instrumental Western classical music from the common practice era.[92] Notable exceptions include; Whiteford et al.'s cross-genre study featuring thirty-four excerpts from a variety of distinct genres (e.g. blues, salsa, heavy metal, jazz, country & western, hip-hop, Arabic,

[90] Alf Gabrielsson, "Strong Experiences with Music," in *Handbook of Music and Emotion: Theory, Research, Applications*, ed. Patrik N. Juslin and John A. Sloboda (Oxford University Press, 2010), 547, https://doi.org/10.1093/acprof:oso/9780199230143.001.0001.

[91] Whiteford et al., "Color, Music, and Emotion," 19. Whiteford et al. suggest that their results reflected learned semantic and statistical cultural correspondences because Ireland is semantically connected to the color green (e.g. Emerald Isle, lush green landscape) and heavy metal music is frequently linked to the color black through cultural conditioning (e.g. prevalence of occult iconography).

[92] Spence, "Assessing the Role of Emotional Mediation in Explaining Crossmodal Correspondences Involving Musical Stimuli," 20.

Hindustani sitar, reggae, dubstep etc.) and Lindborg and Friberg (2015) who used twenty-seven excerpts of film music. To be able to make meaningful generalizations regarding the universality (or lack thereof) of music, emotion and by extension crossmodality, it is necessary to undertake cross-cultural research that expands the breadth of musical genres and traditions under consideration.

Most real-life listening scenarios are significantly longer than the short musical excerpts typically used within the context of crossmodal correspondence studies.[93] Considering the temporal nature of music and the complex network of relationships between auditory stimuli involved (e.g. changes in key, texture, timbre, instrumentation, meter), what aspects of a given musical selection (e.g. average pitch range, volume, orchestration, tempo, tonality, rhythmic structure etc.) ultimately play a role in establishing crossmodal connections?[94] Consequently, when researching crossmodal correspondences with regards to music, it has proven challenging for researchers to determine conclusively which auditory features people might rely on to form correspondences at a given moment. Spence suggests that the answer likely "depends on the particular range of stimuli used, and more importantly, the contrasts, that are emphasized within a given experimental context, or musical excerpt."[95] In other words, real world crossmodal connections formed when listening to music are dynamic in nature and as such are likely influenced by multiple shifting criteria at a given moment (e.g. amodal, emotional, semantic, structural and/or systematic crossmodal correspondences between particularly dominant auditory stimuli, culturally specific associations and personal experience). Another important

[93] For example: Both Whiteford et al. (2018) and Lindborg & Friberg (2015) used excerpts that were fifteen seconds long, while Palmer et al. (2013) used excerpts of fifty seconds.

[94] Spence, 12.

[95] Spence, 4.

generalization to keep in mind with regards to audiovisual improvisation and crossmodal correspondences is that most visual stimuli studied by researchers to date has been static (i.e. color patches or paintings). Further research involving video or multimedia stimuli might uncover new forms of crossmodal correspondences that have yet to be discovered or alternatively that correspondences relying on temporal or synchronous correlation might play an important or even dominant role in creating correspondences across senses in contexts where visuals and music are in a state of flux such as audiovisual performance.[96]

1.9 Comparing Cross Modal Correspondences and Synesthesia

Despite the wide variety of ways that synesthesia can manifest, what frequently draws people to the phenomenon is a fascination with atypical connections between distinct sensory modalities. O'Callaghan notes: "It is an oddity, an outlier, or a disordered condition. A history of skepticism questions whether it even exists. It has been described as “incredible,” “controversial,” “mysterious,” “unbelievable,” and “romantic neurology.”[97] Growing interest in researching multisensory perception, has demonstrated that connections between sensory modalities and psychological systems —including crossmodal correspondences— are the norm rather than the exception, leading many researchers to debate whether there is a direct relationship between synesthesia and normal perception.[98]

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[96] Spence, 21.

[97] Casey O’Callaghan, “Synesthesia vs. Crossmodal Illusions,” in *Sensory Blending: On Synaesthesia and Related Phenomena*, ed. Ophelia Deroy (Oxford University Press, 2017), 1, https://doi.org/10.1093/oso/9780199688289.003.0003.

[98] Cohen, “Synesthetic Perception as Continuous with Ordinary Perception, Or,” 1.; Deroy and Spence, “Why We Are Not All Synesthetes (Not Even Weakly So).”

While individualistic pairings between inducer and concurrent are commonly considered to be a defining characteristic of synesthesia (e.g. typically two synesthetes with sound-color synesthesia will not perceive the same color when they hear a particular pitch), two influential studies (Rich et al., 2005; Simner et al., 2005) looking at larger sample sizes of synesthetes together revealed unexpected commonalities not only amongst synesthetes but also controls.[99] For example, amongst grapheme-color synesthetes, letters that occur with high-frequency, such as A and S in English, tend not only to be paired more commonly with primary colors (e.g. red and yellow), but are also perceived to have greater luminance and saturation.[100] Interestingly, studies have shown similar shared cross-modal associations between synesthetes and non-synesthetes for pitch height and lightness and pitch height, size and brightness.[101] The aforementioned findings would suggest that what synesthetes and non-synesthetes likely share is cross modal correspondences, in particular, structural or learned statistical correspondences that are connected with the brain's capacity to interpret our surroundings. The question remains, do shared crossmodal correspondences provide a link between synesthetes and non-synesthetes? While it is possible that some forms of synesthesia and crossmodal correspondences rely on similar cognitive processes/mechanisms, so little is known conclusively about the underlying causes of either, that there is significant debate as to whether or not synesthesia and crossmodal

[99] A. N. Rich, J. L. Bradshaw, and J. B. Mattingley, "A Systematic, Large-Scale Study of Synaesthesia: Implications for the Role of Early Experience in Lexical-Colour Associations," *Cognition* 98, no. 1 (November 1, 2005): 53–84, https://doi.org/10.1016/j.cognition.2004.11.003; Julia Simner et al., "Non-Random Associations of Graphemes to Colours in Synaesthetic and Non-Synaesthetic Populations," *Cognitive Neuropsychology* 22, no. 8 (December 2005): 1069–85, https://doi.org/10.1080/02643290500200122; Ward and Simner, "Chapter 13 - Synesthesia," 291.

[100] Ward and Simner, 292. Results from the aforementioned studies also indicated that synesthetes and non-synesthetes both commonly associated the grapheme A with red at higher-than-expected levels.

[101] Gallace and Spence, "Multisensory Synesthetic Interactions in the Speeded Classification of Visual Size"; Lawrence E. Marks, "On Cross-Modal Similarity: Auditory–Visual Interactions in Speeded Discrimination," *Journal of Experimental Psychology: Human Perception and Performance* 13, no. 3 (August 1987): 384–94, https://doi.org/10.1037/0096-1523.13.3.384; Curwen, "Music-Colour Synaesthesia," 95.

correspondences occupy positions on a shared multisensory continuum or if synesthesia is a distinct neurological phenomenon (for debate see Marks & Mulvenna, 2013; cf Deroy and Spence, 2013, 2016, 2017; Jamal et al., 2017).[102] Several key factors support the hypothesis that synesthetic experiences are distinct from that of non-synesthetes: differences in neural processing; automatic responses to stimuli/inducers; unidirectional and consistent responses to stimuli over time; absolute vs relative mappings of inducer/concurrent.

Researchers have yet to gain a clear understanding of the differences in perception and neural processing between synesthetes and non-synesthetes.[103] Consider the case of audiovisual correspondences: if a synesthete encounters an auditory stimuli automatically inducing the formation of a mental image in a non-stimulated sense, how does this compare to the non-synesthete experience of associating mental images (even vivid ones) with auditory stimuli? Deroy suggests that "the difference [is] found in the fact that synesthetic experiences really present themselves like perceptual experiences, whereas mental images remain subjectively distinguishable from perceptual experiences."[104] Currently, there isn't enough evidence to provide a definitive answer, however, clinical research confirms that the synesthetic experience of perception, for color at least, is structurally distinct from that of non-synesthetes. Van

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[102] Lawrence E. Marks and Catherine M. Mulvenna, "Synesthesia, at and near Its Borders," *Frontiers in Psychology* 4 (September 26, 2013), https://doi.org/10.3389/fpsyg.2013.00651; Deroy and Spence, "Why We Are Not All Synesthetes (Not Even Weakly So)"; Ophelia Deroy and Charles Spence, "Lessons of Synaesthesia for Consciousness: Learning from the Exception, Rather than the General," *Neuropsychologia*, Special Issue: Synaesthesia and Multisensory Processes, 88 (July 29, 2016): 49–57, https://doi.org/10.1016/j.neuropsychologia.2015.08.005.

[103] The APA dictionary of psychology defines perception as: "the process or result of becoming aware of objects, relationships, and events by means of the senses, which includes such activities as recognizing, observing, and discriminating. These activities enable organisms to organize and interpret the stimuli received into meaningful knowledge and to act in a coordinated manner." "APA Dictionary of Psychology," accessed August 1, 2024, https://dictionary.apa.org/perception.

[104] Ophelia Deroy, "Introduction," in *Sensory Blending: On Synaesthesia and Related Phenomena*, ed. Ophelia Deroy (Oxford University Press, 2017), 4, https://doi.org/10.1093/oso/9780199688289.003.0001.

Leeuwen et al. (2010) discovered that neurons involved in synesthetic experiences of color behave differently than those in typical perceptual experiences.[105] Brain imaging studies also indicate that some synesthetes exhibit increased activity in primary sensory brain areas in comparison to non-synesthetes. For example, in subjects with chromesthesia, there is increased activity in areas of the brain where non-synesthetes perceive colors. Even if non-synesthetes are trained to associate sounds with specific colors or are prompted to imagine corresponding colors while hearing sounds, this same increased activation has not been observed.[106]

A defining characteristic of synesthesia is that it has been proven to occur automatically and involuntarily. Unlike crossmodal correspondences, synesthesia cannot be simply "inhibited at will."[107] On the other hand, while crossmodal correspondences don't induce the vibrant perceptual experiences reported by synesthetes, research has suggested that crossmodal correspondences can also impact our perception and cognition in automatic and subconscious ways.[108] For example, crossmodal correspondences are thought to enhance crossmodal binding, selective attention, motor responses, and in the case of audiovisual correspondences, evidence has shown that pitch height may impact our perception of concurrent visual motion.[109]

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[105] Tessa M. van Leeuwen, Karl Magnus Petersson, and Peter Hagoort, "Synaesthetic Colour in the Brain: Beyond Colour Areas. A Functional Magnetic Resonance Imaging Study of Synaesthetes and Matched Controls," *PLOS ONE* 5, no. 8 (August 10, 2010): e12074, https://doi.org/10.1371/journal.pone.0012074.

[106] Deroy, "Introduction," 5.

[107] Eitan, 219.

[108] Eitan, 215. For example, rather than associating lighter colors with higher pitches, a synesthete with chromesthesia might report actually "seeing" lighters colors in their minds eye when hearing higher pitches.

[109] Lawrence E. Marks, "Cross-Modal Interactions in Speeded Classification," in *The Handbook of Multisensory Processes*, ed. Gemma A. Calvert, Charles Spence, and Barry E. Stein (The MIT Press, 2004), 85–106, https://doi.org/10.7551/mitpress/3422.003.0009; Elena Rusconi et al., "Spatial Representation of Pitch Height: The SMARC Effect," *Cognition* 99, no. 2 (March 1, 2006): 113–29, https://doi.org/10.1016/j.cognition.2005.01.004. Rusconi et al. suggest that in the realm of music, congruent pitch height to key relationships on instruments have resulted in faster and greater accuracy in response times; Fumiko Maeda, Ryota Kanai, and Shinsuke Shimojo,

Typically, relationships between inducer and concurrent(s) are unidirectional and absolute for synesthetes (see 1.1 and 1.3 of this document), while crossmodal correspondences are bidirectional and relative (e.g. pitch - luminosity mappings in research contexts are dependent on presenting a range of pitch and lightness values for comparison).[110] Synesthetic mappings between inducer and concurrent are unique and consistent over long periods of time,[111] while crossmodal correspondences (e.g. pitch-spatial elevation; pitch- brightness, music - emotion) are thought to be universal, or culturally specific, rather than individualistic and can shift as a result of changing contexts and statistics within a given environment.[112]

While there is substantial clinical evidence to support shared crossmodal correspondences between synesthetes and non-synesthetes, it is important remain cautious when making sweeping generalizations about either— especially considering the manifold varieties of synesthesia and uncertainty regarding causes and underlying mechanics of both synesthesia and crossmodal correspondences. In the face of insufficient evidence, rather than purport a direct connection or continuum between crossmodal correspondences and synesthesia, it is perhaps prudent to

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"Changing Pitch Induced Visual Motion Illusion," *Current Biology* 14, no. 23 (December 2004): R990–91, https://doi.org/10.1016/j.cub.2004.11.018; Eitan, 215.

[110] Spence and Sathian, 251.

[111] C. S. Myers, "Two Cases of Synaesthesia," *British Journal of Psychology* 7, no. 1 (May 1, 1914): 112. For example, Alexander Scriabin associated the color violet with the key of F# major while his Russian compatriot Nikolai Andreyevich Rimsky-Korsakov connected it with green; Marcus R. Watson et al., "Synesthesia and Learning: A Critical Review and Novel Theory," *Frontiers in Human Neuroscience* 8 (February 28, 2014), https://doi.org/10.3389/fnhum.2014.00098. Interestingly, Watson et al.'s research indicates that young children with grapheme-color synesthesia experience an increase in grapheme-color associations over time—particularly with regards to pairing similarly shaped and sounding letters with similar colors. Suggesting the possible influence of learned crossmodal correspondences on grapheme-color synesthetes (e.g. through frequency of letter usage).

[112] Eitan, 219.

consider instead, that both synesthetes and non-synesthetes experience crossmodal correspondences as a means of helping to make sense of the world around us.[113]

Part 2: Synesthesia and Crossmodality in the Arts

1.10 The Dream of Synesthesia

> If synesthesia represents the unity of the senses, the dream of synesthesia, is the unification of the arts.
>
> —Jeremy Strick

While a detailed survey of the influence of synesthesia and crossmodal correspondences on Western music and art is beyond the scope of this paper, I aim to link two prevalent facets of audiovisual crossmodal correspondences and synesthesia —color-tone correspondences and shape/sound correspondences— with selected artistic histories and anecdotes from 1900 to 1950 in order to frame the various lineages of collaborative audiovisual improvisation that I will introduce in Chapter 2, as well as those which are relevant to my own artistic practice as discussed within this document.

Nineteenth century romantic and symbolist values celebrated correspondence between the senses.[114] Absolute music was idealized as a means to break from established artistic conventions and was considered by many to be the preeminent discipline to which other artforms should aspire.[115] By the turn of the century, synesthesia became symbolic of, "a mystical vehicle

[113] Spence and Sathian, 252.

[114] Nicholas Cook, *Analysing Musical Multimedia* (Oxford University Press., Inc, 1998), 25. Some of the best-known examples of synesthesia in literature were written by French symbolist poets Arthur Rimbaud and Charles Baudelaire who correlated letters, colors, smells and sounds in their writings (see Baudelaire's *Correspondances* and Rimbaud's *Sonnet des Voyelles*).

[115] Music that has no extra-musical references.

to attain a higher reality or state of consciousness."[116] In painting in particular, the spiritual ideal of synesthesia led many artists to create work that drew inspiration from music or aimed to depict various crossmodal correspondences between musical and visual elements as a means of emancipation from more traditional representational content.[117] Strick notes:

> In effect, the idea of synesthesia served to mediate between music and visual art in the early twentieth century and proved essential to the development of abstraction. Emphasizing the perceiving subject, the theory of synesthesia tended to break down sense perception into discrete units, whereby one sensation found its equivalent in another; music, with its notes and phrases, harmony and dissonance, compositional structures and abstract notational system, lent itself most readily to such analogy.[118]

Surprisingly, there are few documented examples of artists from this time period who professed to have synesthesia in a neurological sense.[119] Rather, artists and musicians at the turn of the century sought to find ways to use audiovisual crossmodal correspondences in their work to evoke the *ideal* of synesthesia in their audiences.[120] Moving forward, I will borrow the term

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[116] Judith Zilczer, "'Color Music': Synaesthesia and Nineteenth-Century Sources for Abstract Art," *Artibus et Historiae* 8, no. 16 (1987): 26, https://doi.org/10.2307/1483303.

[117] E.g. Between musical elements such as pitch, harmony, rhythm and visual ones like color, line, and form.

[118] Jeremy Strick, "Visual Music," in *Visual Music: Synesthesia in Art and Music Since 1900 (Exhibition Catalog)*, ed. Jane Hyun and Elizabeth Hamilton (New York: Thames & Hudson., 2005), 16.

[119] While it is hard to know for certain, many scholars believe that painters Wassily Kandinsky and David Hockney, novelist Vladimir Nabokov, as well as composers Nikolai Rimsky Korsakov, Olivier Messiaen, Duke Ellington, Amy Beach and Alexander Scriabin experienced synesthesia in the neurological sense (cf. recent articles by Gawboy and Townsend, 2012 and Kaykov, 2017 regarding Scriabin).; Anna M. Gawboy and Justin Townsend, "Scriabin and the Possible," *Music Theory Online* 18, no. 2 (June 2012), https://doi.org/10.30535/mto.18.2.2.; Michael Kaykov, "Scriabin's Synesthesia, Demystified," *ICONI*, The Manhattan School of Music, no. 3 (2021): 22–28, https://doi.org/10.33779/2658-4824.2021.3.022-028.

[120] Strick, "Visual Music," 15.; Zilczer, "Color Music," 101. Whether created via new inventions capable of projecting colored lights, paintings with musical subject matter, or various forms of abstraction, the term "color music" is often used to describe the new forms of visual art that were emerging at the turn of the century to embody this synesthetic ideal (Zilczer, 1987, 101); At this point, I would be remis not to mention that the term "Visual Music" has also been used to apply to various artistic trends connected with this same synesthetic ideal and which carry forward to the present day. There are several schools of thought when it comes to what constitutes "Visual Music." Digital artist and composer Brian Evans describes it simply as "time-based visual imagery that establishes a temporal architecture in a way [that is] similar to absolute music." Animation and film historian William Moritz (1941-2004) has poetically called it, "a music for the eye comparable to the effects of sound for the ear." Others

"cultural synesthesia" suggested by Nicholas Cook, and taken up by Mitchell Whitelaw, to differentiate between the neurological phenomenon of synesthesia and the work of artists from the turn of the twentieth century who created work with the ultimate purpose of "evoking and provoking the state of synesthesia, linking color, form, and sound."[121] Judith Zilczer further classifies two predominant approaches to "cultural synesthesia" during this time period: quasi-mystical and pseudo-scientific.[122]

The quasi-mystical approach is exemplified by artists such as James McNeill Whistler (1834-1903), Arthur Wesley Dow (1857-1922), Arthur Dove (1880-1946) and Georgia O'Keeffe (1887-1986) who used music as subject matter to create abstract paintings.[123] Others, like early

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such as Ari Wiseman, have expanded the definition to encompass a broad range of artistic practices that "...assimilate abstract qualities found in music - including movement, rhythm, tempo, mood, counterpoint, intensity, harmony, and compositional structure - within visual phenomena…." Within the historiography of visual music, artists working with diverse materials and methods have coined specific terms to describe idiosyncratic processes for integrating visual and sonic elements. Brian Evans, "Foundations of a Visual Music," *Computer Music Journal* 29, no. 4 (2005): 11; William Moritz, "Towards an Aesthetic of Visual Music," 1986, http://www.centerforvisualmusic.org/TAVM.htm; Ari Wiseman, "Expanding the Synaesthetic Paradigm," in *Visual Music: Synesthesia in the Art and Music since 1900*, ed. Jane Hyun and Elizabeth Hamilton, 2005, 181.

[121] Cook, *Analysing Musical Multimedia*, 49; Mitchell Whitelaw, "Synesthesia and Cross-Modality in Contemporary Audiovisuals," *The Senses and Society* 3, no. 3 (November 2008): 265, https://doi.org/10.2752/174589308X331314; Strick, "Visual Music," 20.

[122] Zilczer, "Color Music," 102.

[123] James McNeill Whistler used titling to allude to the influence of music on his work (e.g. Nocturne in Black and Gold: Falling Rocket (ca 1872-1877). He believed: "As music is the poetry of sound, so is painting the poetry of sight[...] The great musicians know this... they constructed celestial harmonies[...]Art should...appeal to the artistic sense of eye or ear,...and that is why I insist on calling my works arrangements and harmonies." James McNeill Whistler, *The Gentle Art of Making Enemies, Ed. by Sheridan Ford.* (New York: F. Stokes & Brother, 1890), 69–70.(pg. 69-70); Dow was a painter and influential educator who taught at Columbia University from 1904-1922 (Georgia O'Keeffe and Stanton Macdonald-Wright were among his students). Dow's seminal pedagogical volume *Composition* (first published in 1899), expounds on his belief in the importance of using music as an analogy in visual art. For example: "The masters of music have shown the infinite possibilities of variation — the same theme appearing again and again with new beauty, different quality and complex accompaniment. Even so can lines, masses and colors be wrought into musical harmonies and endlessly varied." Arthur Wesley Dow, *Composition: A Series of Exercises in Art Structure for the Use of Students and Teachers* (Garden City, NY: Double Day, Duran and company Inc., 1913), 38.; Zilczer, "Color Music," 102.; Arthur Dove was an American painter who used music as inspiration for his abstract paintings. Zilczer notes that "Dove listened to music while painting and drawing. His wife recorded in her diary that he worked on his jazz paintings while listening to records of George Gershwin's music. His involvement with synesthesia led him to devise a linear notation system for transcribing musical sound. The linearity of such paintings as Improvision (1927) resulted from this working method." Zilczer, 111. During her

abstractionists Wassily Kandinsky (1866-1944) sought to create visual analogies for musical elements—e.g. counterpoint and harmony— in pursuit of "mystical theories of synesthesia."[124] In his influential text from 1912, *On the spiritual in Art*, Kandinsky theorized:

> The adaptability of forms, their organic but inward variations, their motion in the picture, their inclination to material or abstract, their mutual relations, either individually or as parts of a whole; further, the concord or discord of the various elements of a picture, the handling of groups, the combinations of veiled and openly expressed appeals, the use of rhythmical or unrhythmical, or geometrical or non-geometrical forms, their contiguity or separation—all these things are the material for counterpoint in painting.[125]

Ultimately, Kandinsky, believed that art should be created as a means to pursue the spiritual: "The spiritual life, to which art belongs and of which she is one of the mightiest elements, is a complicated but definite and easily definable movement forwards and upwards."[126] As such, his relationship to synesthesia, both "cultural" and neurological—Kandinsky is believed to have experienced chromesthesia— ultimately served a higher purpose.

Around the same time as Kandinsky was developing his metaphysical theory of correspondences between visuals and music, many artists in Paris were approaching the ideal of "cultural synesthesia" with a more rational outlook, influenced by new advancements in

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time as a student of Dow at the University of Columbia, Georgia O'Keeffe was exposed to the process of drawing while listening to music. O'Keeffe recalled: "...A low tone record was being played and the students were asked to make a drawing from what they heard. I sat down and made a drawing, too[…]This gave me an idea that I was very interested to follow later– the idea that music could be translated into something for the eye." Georgia O'Keeffe, *Georgia O'Keeffe.*, A Studio Book (New York: Viking Press, 1976).; O'Keeffe's subsequent series of visual translations which she called *Specials*, would serve as inspiration for works such as *Blue and Green Music* (1921) and *Music–Pink and Blue II* (1919). Judith Zilczer, "Music for the Eyes: Abstract Painting and Light Art," in *Visual Music: Synesthesia in Art and Music Since 1900 (Exhibition Catalog)*, ed. Jane Hyun and Elizabeth Hamilton (New York: Thames & Hudson., 2005), 59.

[124] Zilczer, "Color Music," 103.

[125] Wassily Kandinsky, *Concerning the Spiritual in Art*, trans. Michael Sadleir (New York: Dover Publications, 1977), 33.

[126] Kandinsky, 4.

scientific research. In particular, optics, the physiology of vision, and the discovery that light and sound could both be expressed physically as waves, inspired many artists to invent idiosyncratic systems of correspondences between light and sound.[127] Czech painter František Kupka (1871-1957) for example, explored the idea of shared vibrations between light and sound through the use of bright colors and "radiating patterns."[128] From 1911-1913, Paris-based American artists Morgan Russell (1886-1953) and Stanton Macdonald-Wright (1890-1973) were proponents of *Synchromism*, a style of painting which aimed to draw connections between color harmony and rhythm in musical and visuals, through a complex system of correspondences between pitch and color. Synchromism derived its name from the words "color" and "symphony." In the following passage, Russell describes how he and Macdonald-Wright used "color rhythms" to evoke a sense of temporality in their work:

> In order to resolve the problem of a new pictorial structure, we have considered light as intimately related chromatic waves, and have submitted the harmonic connections between colors to a closer study. These "color rhythms" somehow infuse a painting with the notion of time: they create the illusion that the picture develops, like a piece of music, within a span of time, while the old painting existed strictly in space, its every expression grasped by the spectator simultaneously and at a glance.[129]

Russell and Macdonald-Wright were especially interested in finding ways to depict the temporal aspect of music by creating the illusion of movement (i.e. amodal correspondences); this desire eventually led to experimentation with the design of a kinetic light machine dubbed the Synchrome Kineidoscope which they hoped would allow color to be perceived on both a spatial

[127] Zilczer, "Music for the Eyes: Abstract Painting and Light Art," 35–38.

[128] Zilczer, 43.

[129] Morgan Russell "Individual Introduction," in Les Synchromistes S.Macdonald-Wright et Morgan Russell, exh. cat. (Paris: Bernheim-Jeune & Cie, 1913), in Gail Levin, *Synchromism and American Color Abstraction, 1910-1925*, G. Braziller (New York, 1978), 130.

and temporal plane.[130] Between the wars, Swiss painter Paul Klee (1879-1940), also an accomplished violinist, began to develop a complex system of correspondences to express musical structure in painting. Klee, who was especially drawn to the formal and harmonic structure of music from the Baroque and Classical eras—in particular J.S. Bach and Wolfgang Amadeus Mozart—was interested in finding ways to express the concept of musical polyphony through painting:

> There is polyphony in music. In itself the attempt to transpose it into art would offer no special interest. But to gather insights into music, through the special character of polyphonic works, to penetrate deep into this cosmic sphere...and then lurk in waiting for these things in the picture, that is something more. For the simultaneity of several independent themes is something that is not just possible in music.[131]

Rather than creating paintings in response to music, Klee used an intricate system of crossmodal correspondences between musical and visual elements (e.g. color, pattern, line, shape) to "compose" new visual compositions.[132]

1.11 Pitch-Color Correspondences and Color Organs

[130] Zilczer, 46.; Unfortunately, due to financial reasons their design was not realized before the outbreak of WWI and it wasn't until the late 1950's that Macdonald-Wright was able to return to the idea and complete the first Kineidoscope prototype. "Q and Art: Stanton Macdonald-Wright and His Kinetic Art Machine | Smithsonian American Art Museum," accessed August 5, 2024, https://americanart.si.edu/blog/eye-level/2014/22/526/q-and-art-stanton-macdonald-wright-and-his-kinetic-art-machine.; Adriano Abbado, *Visual Music Masters: Abstract Explorations: History and Contemporary Research* (Milano, Italy: Skira Editore S.p.A., 2017), 44.Other artists such as Robert Delauny (1885-1941) and Hans Richter (1888-1976) approached the idea of temporality in their work by creating scroll paintings that were meant to draw the viewer through a specific succession of images depicting a continuum or transformation of visual materials over a period of time.

[131] Paul Klee, *Paul Klee: The Thinking Eye; the Notebooks of Paul Klee*, ed. Jürg Spiller (New York: George Wittenborn, 1961), 269.

[132] Zilczer, "Music for the Eyes: Abstract Painting and Light Art," 52–55. In 1920, Klee was appointed as faculty at the Bauhaus in Weimar, Germany where he had the opportunity to refine and catalog his compositional system for pedagogical purposes.

Color-pitch correspondences have fascinated artists, philosophers and scientists since Antiquity. In the Western world, discussions of color-pitch correspondence can be traced back to Pythagoras and Aristotle. In the seventeenth and eighteenth centuries, scholars such as Jesuit mathematician Athanasisus Kirchner (1601-1680), Sir Isaac Newton (1643-1727), and Johann Wolfgang von Goethe (1749-1832), theorized correspondences between light and sound. Drawing on Kirchner's ideas, fellow Jesuit Louis-Bertrand Castel (1688-1757), designed the first ocular harpsichord in 1725. Although there is no clear evidence to support the idea that Castel was able to construct a fully functioning model of his design, his experiments would prove to be the harbinger of a series of increasingly sophisticated luminous instruments invented over the course of the next two centuries.[133]

In 1892, enabled by technological advancements in electric lighting, Alexander Wallace Rimington (1854-1918) patented a device he called a Color-Organ. He would go on to demonstrate its capabilities two years later for an audience of a thousand in London St. James Hall in London.[134] Thereby transforming "the color organ from a curiosity of the inventor's workshop into a working instrument in the artist's studio."[135] Although Rimington was just one of several artists creating luminous instruments at the time, he was perhaps the most well-known, and subsequently the moniker 'color organ' was adopted as the generic term to categorize instruments that projected light. [136] Rimington believed in scientific correspondences between

[133] Kenneth Peacock, "Instruments to Perform Color-Music: Two Centuries of Technological Experimentation," *Leonardo* 21, no. 4 (1988): 401, https://doi.org/10.2307/1578702.

[134] Peacock, 402.

[135] Zilczer, "Music for the Eyes: Abstract Painting and Light Art," 70.

[136] Abbado, *Visual Music Masters: Abstract Explorations: History and Contemporary Research*. See Pages 10-42 for a detailed survey of other artists and luminous instruments from the same time period.; Zilczer, "Music for the Eyes: Abstract Painting and Light Art," 70.

sound and color, based on a theory of shared vibrating frequencies. In his book *Color-Music: The Art of Mobile Color* (1911) he explained: "As most of us know, according to generally accepted scientific theory all colors are produced by varying frequencies of vibration of the ether acting upon the retina of the eye, and all musical sounds by varying frequencies of air vibration acting upon the ear. Both color and sound, as we perceive them, are due to vibrations which stimulate the optic and aural nerves respectively.[137] Rimington's theory involved using ratios to divide the spectrum of light into intervals which he believed roughly matched the proportion of an octave in music (i.e. 2/1).[138] More practical for public performance than many prior luminous instruments, Rimington's Color-Organ was still imposing, towering approximately ten feet in the air:

> A complex apparatus, it employed 14 arc lamps and many filters varnished with aniline dye. It also required a power supply capable of providing 150 amps. The five-octave keyboard resembled that of an ordinary organ and was connected by a series of trackers to a corresponding set of diaphragms in front of special lenses. Stops were furnished to control the three variables of color perception: hue, luminosity, and chroma (color purity). One stop allowed the performer to spread the spectrum band over the entire keyboard instead of over one octave-proof of Rimington's flexible attitude concerning the analogy between particular colors and tones.[139]

Projected onto a white screen or curtain, the intensity of the light was controlled using a pedal which allowed for the possibility of fading colors in and out during performance.[140] Rimington's Color-Organ didn't produce sound but had the same layout as a traditional five-octave keyboard, meaning that one could perform any conventional piece of music on the instrument and see the

[137] A. Wallace Rimington, *Colour Music : The Art of Mobile Colour* (London: Hutchinson & Co, 1912), 16–17.

[138] Peacock, "Instruments to Perform Color-Music," 401–2.

[139] Peacock, 402.

[140] Abbado, 17.

corresponding pitches projected as colored light without necessitating the invention of a new system of notation.[141]

Syrian-born American pianist, Mary Hallock-Greenewalt (1871–1951) was an accomplished concert pianist and prolific inventor who patented a "light-color" instrument called the Sarabet named in honor of her Syrian mother, Sarah Tabet.[142] The Sarabet consisted of seven colored lights and a sliding rheostat that allowed her to smoothly fade colors in and out.[143] Michael Betancourt notes that Hallock-Greenewalt "became an electrical engineer in order to invent the Sarabet... By the time of her death, she had received eleven patents for devices necessary for a variety of visual music she called 'Nourathar.'"[144] Nourathar is a term Hallock-Greenewalt created by combining the *nour* Arabic for "light" with *athar* translating roughly to "essence". Unlike Rimington, Hallock-Greenewalt developed a specialized graphic notation to facilitate performances on the Sarabet (see Figure 1.5 for an example of Hallock-Greenewalt's "Notation for Indicating Lighting Effects"). Rather than explore crossmodal correspondences

[141] Zilczer, "Color Music," 71. Rimington recommended that his Color-Organ be paired with music—specifically a simultaneous performance by a musical instrument—to add to the impact of the projections during performance. Peacock, "Instruments to Perform Color-Music," 402.

[142] As a concert pianist Hallock-Greenewalt performed as a soloist with both the Philadelphia and Pittsburgh orchestra.

[143] Abbado, 29.; "A rheostat is a variable resistor which is used to control current. They are able to vary the resistance in a circuit without interruption." "Rheostat | Resistor Types | Resistor Guide," accessed August 6, 2024, https://eepower.com/resistor-guide/resistor-types/rheostat/. William Moritz, "The Dream of Color Music, And Machines That Made It Possible," *Animation World Magazine*, no. 2.1 (April 1997): 1, https://www.awn.com/mag/issue2.1/articles/moritz2.1.html.Two of Hallock-Greenewalt's inventions the sliding rheostat and liquid-mercury switch, have since become standard electric tools.

[144] Michael Betancourt, "Mary Hallock-Greenewalt's 'Abstract Films,'" *Millennium Film Journal*, October 1, 2006, 55, https://www.academia.edu/111505719/Mary_Hallock_Greenewalts_Abstract_Films.; William Moritz notes that: "When other people (including Thomas Wilfred) began infringing on her patents by using adaptations of the rheostat and mercury switch, she tried to sue, but a judge ruled that these electric mechanisms were too complex to have been invented by a woman, and denied her case." Moritz, "The Dream of Color Music, And Machines That Made It Possible."

between pitch and hue, Hallock-Greenewalt was most interested in cultivating a language she called "light-color play" that was mediated by emotion:

> The very form of light-color play used as a medium for human expression is made through time. The picture features through lineament, through line. In Nourathar, it is a matter of asking at what moment did this brightness begin to wax or wane? What instant did shade give way to another? When did the highest climax attain? When the instant that all light became gradually extinguished into the total of darkness? When this color? When that? It does not ask at what spot on this canvas or sheet does the value begin to shape a nose, a mouth, or image of any sort.[145]

Hallock-Greenewalt was a believer in the potential healing and therapeutic properties of Nourathar and the Sarabet, and was also one of the first artists to make hand-painted films. However, they were not intended to be projected on a screen but rather played using the Sarabet.[146] Zilczer reminds us that the color organ performances by artists such as Hallock-Greenewalt and Rimington, straddled the worlds of theatre, music and visual arts —requiring venues that could accommodate a range of technical needs. As a consequence, performances most frequently took place in concert-halls rather than galleries (a space that Hallock-Greenewalt in particular would have been comfortable in) and would pave the way for future developments in kinetic art and live visuals to come.[147]

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[145] Mary Elizabeth Hallock- Greenewalt, *Nourathar, the Fine Art of Light Color Playing, by Mary Hallock Greenewalt* (Pennsylvania: Westbrook publishing company, 1946), 221, https://hdl.handle.net/2027/mdp.39015022207529.

[146] Anne Ciecko notes that this idea was likely a response to the untimely death of her mother at the age of 28: "Hallock-Greenewalt celebrated her mother's short life and lamented the tragedy and travesty of the circumstances that contributed to the onset of her illness. There is evidence that she hoped that her inventions, such as the Sarabet color organ and Nourathar art form, would honor her mother and be put to therapeutic (as well as artistic and commercial) use." Anne Ciecko, "Mary Hallock-Greenewalt's Spectral Middle East: Autobiographical Orientations and Reflexive Mediations," *Feminist Media Histories* 3, no. 1 (2017): 26, https://doi.org/10.1525/fmh.2017.3.1.25.; Abbado, *Visual Music Masters: Abstract Explorations: History and Contemporary Research*, 29.

[147] Zilczer, "Color Music," 71. Following in the footsteps of Rimington, between 1911-1930, many other artists across Europe and America invented luminous instruments intended to be used for performing color music. For example: Adrian Bernard Klein, Ludwig Hirschfeld-Mack, Alexander László, G.I Gidoni, and Czech artist Zdeněk Pešánek, among others.

1.12 Shape-Sound Correspondences: Graphic Notation

Crossmodal correspondences feature prominently in traditional Western music notation. Higher pitch is typically depicted at a "higher" spatial position or relatively higher on the page, and gradual shifts in volume are frequently notated using wedge-like symbols —*crescendi* and *decrescendi*— where change in spatial width is understood to translate as increasing or decreasing loudness (crossmodal correspondences between size and volume.[148] Sounds with shorter articulations (*staccato*), are accompanied by a dot over the note head to reinforce the relative brevity of attack while smoother melodic lines are joined by curving lines to indicate the opposite (*legato*) (see Figure 1.2).[149] In each of the aforementioned examples, aspects of the shape of notation itself (spatial location on the page, relative size) correspond to various sonic characteristics.

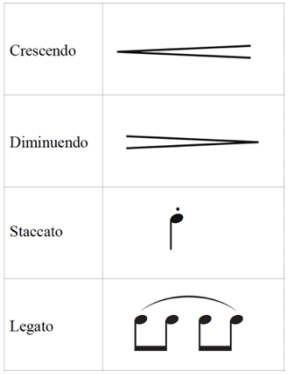

Figure 1.2: Some Examples of Conventional Western Musical Notation

In Western musical notation, tapering the end of a shape frequently correlates to a gradual decrease in a particular audio characteristic—most often volume. In the first half of the twentieth century, as notation began to evolve to incorporate new instrumental techniques, tapering could also signify a reduction in other attributes (e.g. bow pressure). A similar shape-sound

[148] Eitan, "Musical Connections," 213.

[149] Sharp and smooth are semantic crossmodal correspondences frequently used in music to correlate between touch and sound.

correspondence holds true in digital audio workstations and video editing software, where graphics indicating decreases in volume, brightness or gradually blending between two sound or video files are symbolized using tapered shapes/lines (see Figure 1.3).

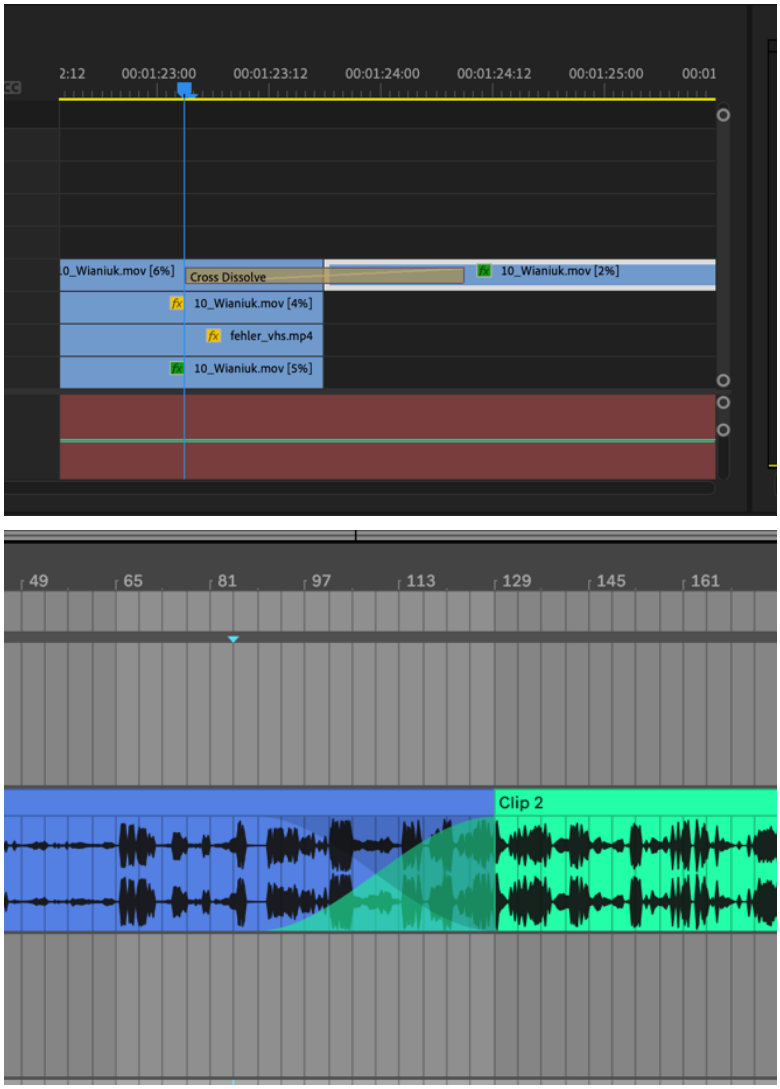

Figure 1.3: Screen shot of a Cross Dissolve between two video files in Premiere Pro (pictured at top).[150] Screen shot of a Cross Fade between two audio clips in Ableton Live (pictured at bottom).[151]

[150] Premiere Pro is a timeline-based video editing software created by Adobe.

[151] Ableton Live is a popular DAW (digital audio workstation)

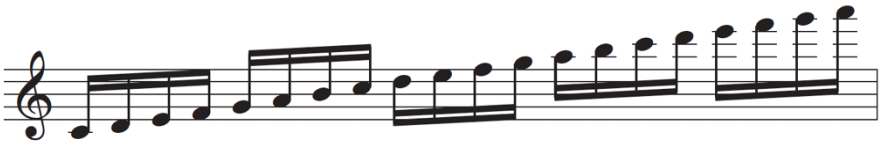

Figure 1.4: Ascending sequence of pitches to illustrate crossmodal correspondences between shape-sound and gesture.

For performers, shape-sound symbolism in music is also frequently mapped, via statistical correspondences, to gesture or motion.[152] For example, a sequence of pitches moving from low to high over a specific duration —will appear as a succession of discreet symbols moving from left to right on the x axis of the page and from low to high in terms of spatial elevation relative to the y axis (see Figure 1. 4). Interpreting these symbols would result in a single gesture—or multiple successive gestures— in a corresponding motion from left to right and bottom to top or vice versa (depending on the anatomy of the instrument in question).

Over the course of the twentieth century, the incorporation of various extended instrumental techniques and evolving musical relationships between composers and performers (e.g. indeterminacy) merited shifts in the musical parameters that traditional notation needed to represent graphically. Julia Schröder notes:

> The first graphic notations and musical graphics were produced within the New York school of composers around John Cage: Morton Feldman's Projection from 1950 was the first instance of graphic notation (called graph notation), and Earle Brown's December 1952 is often deemed the first work of musical graphics (called musical graph). However, the term musical graphics, or *Musikalische Grafik*, was coined by Roman Haubenstock-Ramati in Europe, where in the late 1950s a music-theoretical discussion began that primarily revolved around the dissolution of the concept of the work of art and the aesthetics of autonomy.[153]

[152] The size of gesture will vary greatly depending on the instrument and means of sound production.

[153] Julia H. Schröder, "Graphic Notation and Musical Graphics: Between Music Notation and Visual Art," in *See This Sound: Audiovisuology Compendium: An Interdisciplinary Survey of Audiovisual Culture* (Köln: Ludwig Boltzmann Institute, 2010), 50.

Graphic notation can include or extend existing components of traditional notation or alternatively, shift away entirely from recognizable musical symbols (e.g. incorporate text, images, shapes, audio, and/or video recordings). A key feature of graphic notation is indeterminacy, along with improvisatory practices. Cage (1912-1992) described the nature of indeterminate notation as: "Being unforeseen, this action is not concerned with its excuse. Like the land, like the air, it needs none. A performance of a composition which is indeterminate of its performance is necessarily unique. It cannot be repeated. When performed for the second time the outcome is other than it was."[154] According to Lewis, the shift in Western art music away from the trappings of the work-concept, that had been so dominant in Classical music since the early nineteenth century and towards improvisation, was "due in no small measure to musical and social events taking place in quite a different sector of the overall musical landscape. In particular, the anointing, since the early 1950s of various forms of 'jazz,' the African American musical constellation most commonly associated with the exploration of improvisation in both Europe and America, as a form of 'art' has in all likelihood been a salient stimulating factor in this reevaluation of the possibilities of improvisation."[155] Feisst notes that despite Cage's enthusiasm for indeterminacy and musical processes involving improvisational elements, "throughout most of his career, Cage displayed ambiguity and adversity towards improvisation and warned performers against improvisatory performances of his own scores, challenging his society's well-worn concepts of free music making and improvisation, particularly in the context

[154] John Cage, *Silence: Lectures and Writings* (Wesleyan University Press, 1961), 39.

[155] George E. Lewis, "Improvised Music after 1950: Afrological and Eurological Perspectives," *Black Music Research Journal* 16, no. 1 (1996): 91–92, https://doi.org/10.2307/779379.

of new music."[156] See Lewis and Braxton for a critical examination of how Cage and other experimental composers of the 1950's and 1960's used indeterminacy in their work to "bypass the word improvisation and as such the influence of non-white sensibility."[157]

Interestingly, Hallock-Greenewalt's "Notation for Indicating Lighting Effects" (patented in 1921) used a unique set of symbols, very similar to those used by experimental composers in the 1950's and 1960's to represent changes in lighting effects over time (see Figure 1.5).[158] Unsurprisingly considering her training, some symbols, in particular those indicating increases or decreases in brightness — "Brightling" or "Darkling" as she referred to them—bear a striking resemblance to crescendi and decrescendi and represent what were likely intuitive statistical amodal correspondences between brightness and intensity (see Figure 1.6 for comparison to Krzystof Penderecki's use of similar shapes to covey increases or decrease in ranges of pitch that the performer can choose from).[159] Hallock-Greenewalt annotated traditional musical scores with her idiosyncratic notation, hereafter dubbed Light-Scores, so that indications for lighting corresponded with temporality of the sounding material on a linear timeline. Thus, transferring her skills as an interpreter from the medium of sound to the medium of light.

[156] Sabine M Feisst, "John Cage and Improvisation: An Unresolved Relationship," in *Musical Improvisation: Art, Education, and Society , Edited by Gabriel Solis and Bruno Nettl.*, ed. Gabriel Solis and Bruno Nettl (Urbana: University of Illinois Press, 2009), 38.

[157] Anthony Braxton, *Tri-Axium Writings , Anthony Braxton.*, vol. 1 (San Francisco, CA: Synthesis Music, 1985), 36; Lewis, "Improvised Music after 1950."

[158] Michael Betancourt, *Mary Hallock-Greenewalt: The Complete Patents* (Wildside Press, 2005), 34.

[159] Lars Bröndum, "Graphic Notation, Indeterminacy and Improvisation: Implementing Choice Within a Compositional Framework," *Open Cultural Studies* 2, no. 1 (2018): 641, https://doi.org/10.1515/culture-2018-0058.

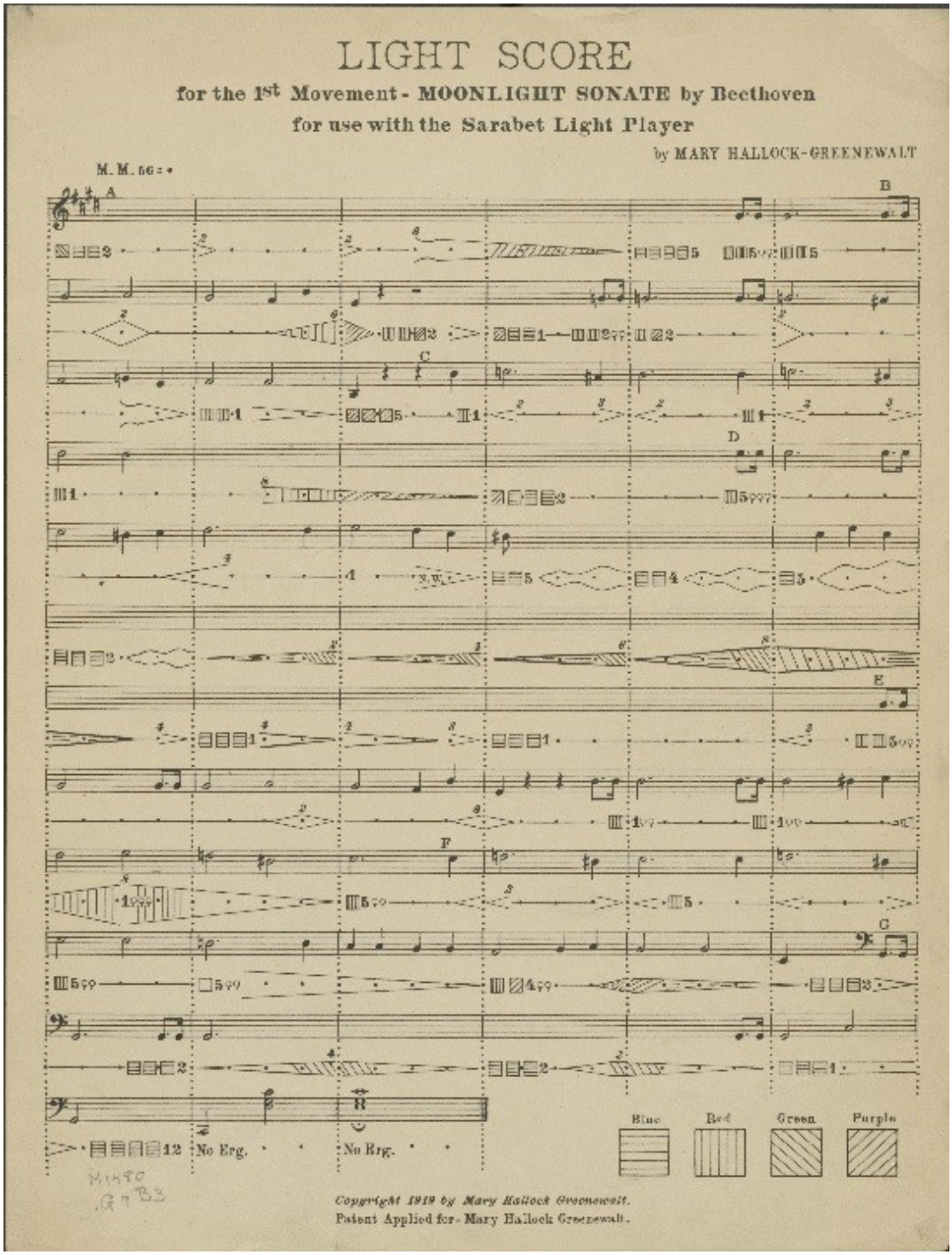

Figure 1.5: Light Score for use with the Sarabet Light Player by Mary Hallock-Greenewalt. Copyright 1919.

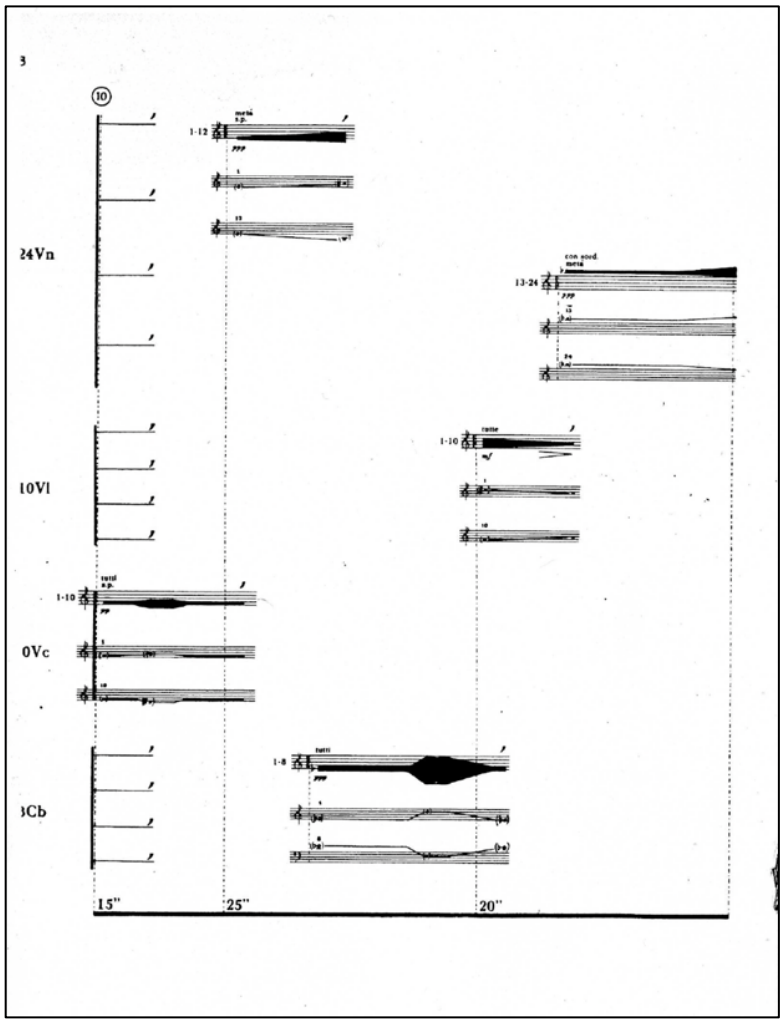

Figure 1.6: Score sample of Krzysztof Penderecki's Threnody for the Victims of Hiroshima (1960)

1.13 Shape-Sound Correspondences: Abstract Film and Optical Film

"Cultural synesthesia" and "color music" are deeply embedded in the history of abstract film. The first documented examples were created in 1910 by Italian Futurist brothers Arnaldo Ginna (1890-1982) and Bruno Corra (1892-1976). Although none of the brothers' films has managed to survive, Corra's description of their early experiments to develop a "music of colors", is chronicled in the text, "Abstract Cinema - Chromatic Music." Abstract films

sometimes called “absolute films” were intended to parallel the genre of “absolute music” by presenting imagery on screen that could only be expressed through the medium of cinema. In the 1920’s, absolute film was taken up by Swiss artist Viking Eggeling (1880-1925) and several notable German painters; Walter Ruttman (1887-1941), Oskar Fischinger (1900-1967), and Hans Richter. Filmmakers working in abstract/absolute film used a variety of approaches ranging from scratching and hand painting directly on film to experimental techniques in cinematic and optical animation.

Fischinger was among several artists in Germany and the Soviet Union who became independently interested in developing ways of manipulating and synthesizing sound-on-film in the 1920’s and 1930’s. In 1932, Fischinger photographed geometric patterns, drawn by hand with pen and ink, and applied the result to celluloid, creating films called *Ornament Sound Experiments* where sound and visuals were organically linked. He believed that drawings had the capability to capture the oscillation of a sound wave in graphic form and “set about codifying the visual images of such sounds recorded on photographic film. His aim, at least partially realized, was a visual calligraphy of sound that could be used in the creation of soundtracks.”[160] Fischinger's *Ornament Sound Experiments*, yielded interesting results. Perhaps most surprising was a soundtrack based on an Egyptian pictograph of a snake which, once synthesized made a hissing sound.[161] Describing the outcome of his experiments layering various drawn sounds together, Fischinger remarked:

[160] Judith Zilczer, “American Rhapsody: From Modern to Postmodern in Visual Music,” in *The Oxford Handbook of Sound and Image in Western Art*, ed. Yael Kaduri (Oxford University Press, 2016), 9, https://doi.org/10.1093/oxfordhb/9780199841547.013.5; Richard S. James, “Avant-Garde Sound-on-Film Techniques and Their Relationship to Electro-Acoustic Music,” *The Musical Quarterly* 72, no. 1 (1986): 84.

[161] James, 84.

> In reference to the general physical properties of drawn sounds, we can note that flat and shallow figures produce soft or distant-sounding tones, while moderate triangulation give an ordinary volume, and sharply-pointed shapes with deep troughs create the loudest volume. Shades of grey can also play a significant role in drawn music-ornaments. High-contrast definition of the wave form decisively creates the prevalent sound effect, but as long as one places such a "positive" (well-defined) wave somewhere in the foreground, one can simply overlay other wave patterns simultaneously by using grey shades for the secondary sound effects. Study of sample soundtracks containing these complex tonal patterns reveals that not only do the layered ornaments produce refined, intricate musical sounds but also they appear unexpectedly as attractive abstract visual images.[162]

Despite Fischinger's short foray into optical sound, his main interest throughout his career remained abstract film.

Following in Fischinger's footsteps, prolific Scottish-Canadian animator Norman McLaren (1914-1987) experimented with drawing and scratching directly on film. His first short films, *Rumba* (1939), *Dots* (1940), and *Loops* (1940), are whimsical animations whose abstract shapes generate a soundtrack of repetitive percussive sounds. In the 1950's and 1960's, McLaren's pursuit of more complex audiovisual relationships than could be achieved by drawing directly on celluloid, led him to expand significantly upon existing techniques involving photographing and manipulating images of pre-drawn sounds.[163] Similarly, in pursuit of "audiovisual music" John and James Whitney developed a method for synthesizing sounds optically using pendulums of variable lengths and weights attached to the aperture of a camera. In *Five Film Exercises* (1943-1944) the Whitney brothers synched optically synthesized audio

[162] "Fischinger. Sounding Ornaments," accessed August 7, 2024, https://asmir.info/lib/fischinger.htm. First published in the DEUTSCHE ALLGEMEINE ZEITUNG, July 8, 1932.

[163] James, 84.

created using their "pendulum cluster" device with images shot using light modulated with stencils.[164]

Daphne Oram (1925-2003) was a pioneering British sound engineer and composer who was appointed as the founding director of the BBC Radiophonic Workshop in 1958 and was the inventor of "Oramics"—a method of sound synthesis based on optics. Manning notes that Oram's inspiration can be traced back to her early work as a "music balancer" at the BBC in 1944.[165] During Oram's initial technical training, she recalls being fascinated by her first encounter with a cathode ray oscilloscope:

> And there I saw for the first time the oscilloscope which as you know is showing on the screen the patterns of whatever is incoming from the microphone, and I was allowed to sing into it and there I saw my own voice as patterns on the screen, graphs, and I asked the instructors why we couldn't do it the other way around and draw the graphs and get the sound out of it, I was eighteen I think and they thought this was pretty stupid, silly teenage girl asking silly questions, but I was quite determined from that time on that I would investigate that, but I had no oscilloscope.[166]

After leaving the BBC in 1959, Oram would use two substantial grants from the Gulbenkian Foundation to develop her "Oramics" project. Hutton described Oram's machine as an invention "where physical hand movements [were] imprinted onto transparent film strips and passed across electronic photo sensors from where they are converted into sound. It is a system of graphical notation on which are imposed the necessary components, such as pitch, duration, envelope

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[164] Marcel Schwierin and Naumann Sandra, "The Musicality of Abstract Film," in *See This Sound:Audiovisuology Compendium*, ed. Dieter Daniels, Sandra Naumann, and Jan Thoben (Ludwig Boltzmann Institute, 2010), 21.

[165] Peter Manning, "The Oramics Machine: From Vision to Reality," *Organised Sound* 17, no. 2 (August 2012): 138, https://doi.org/10.1017/S1355771812000064.

[166] Oram, D. 1991. Written transcript of interview with Daphne Oram, 1 June 1991, Tower Folly, Fairseat, Kent, 01 June 1991. In the documents section of the Hugh Davies Archive (2007) London: British Library. as quoted in Manning, 2012, p. 138

shape, timbre, for representing audio waveforms to generate sound electronically."[167] It is not clear exactly to what extent Oram was aware of other innovators in the field of optical film (e.g. Fischinger, McLaren), however, Oram's machine while relying on similar mechanics to comparable inventions of the time period "offered finer nuances of sound manipulation, greater flexibility and simultaneity in the creation of sound than its predecessors."[168]

1.14 An Introduction to Crossmodal Correspondences in my Artistic Practice: *Within Worlds* - Experiments in Audiovisual Improvisation, Fixed Media and Graphic Notation

> I find the experience of starting my practice session by tuning intervals to be a meditative and grounding one. The longer I play an interval, the more it feels as if my ears are able to 'see' new colors and textures emerge within the sound.
>
> Ilana Waniuk

I consider my engagement with sound —whether as performer, listener or practitioner— to be something visceral and multisensory. In relation to my training as a violinist, I am especially cognizant of correspondences between touch, sound and visuals and their influence on my creative work. Inspired by my experiences tuning intervals as a string player (see the above epigraph taken from my DMA Qualifying Exam),[169] *Within Worlds* (2022) for flute, violin, live electronics and fixed audiovisual media follows the tradition of artists, scientists and philosophers who have been fascinated by correspondences —whether absolute, relative, or interpretive— between waves of light and sound. Written for in^set, *Within Worlds* is based on

[167] Jo Hutton, "Radiophonic Ladies," Sonic Arts Network, 2000.

[168] Jo Hutton, "Daphne Oram: Innovator, Writer and Composer," *Organised Sound* 8, no. 1 (April 2003): 54, https://doi.org/10.1017/S1355771803001055.

[169] "The distance between two pitches is called an interval, and can be measured by comparing the frequency ratio between them." Ilana Waniuk, "DMA Qualifying Exam. Question III" (University of California San Diego, 2021), 3.

the idea of what it might feel like to be immersed in the spectra of a composite complex soundwave.[170] Borrowing from the field of microscopy, I wanted to take the concept of zooming in on the familiar to reveal the unknown and apply it to sound, integrating our artistic practice as an ensemble through using close up footage of our respective instruments to provide a window —by way of a projector screen— into the hidden worlds of precious objects that are a part of our everyday experience as musicians.[171] *Within Worlds* also draws inspiration from a frequently used acoustics metaphor comparing the harmonic series to the spectrum of visible light.[172] While I didn't set out to explicitly create a work built on crossmodal correspondences between pitch, hue, timbre, texture and brightness, I used graphic notation, audiovisual improvisation, fixed media and staging instructions in an attempt to reinforce the aforementioned audiovisual metaphors.[173]

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[170] "in^set is a flexible chamber ensemble dedicated to creation, improvisation and experimentation. Founded in 2018 by David Aguila (trumpet), Teresa Díaz de Cossio (flute), and Ilana Waniuk (violin), in^set is committed to commissioning and performing existing compositions which extends our respective instrumental practices beyond the confines of contemporary classical music. Our collaborative creative work seeks to explore the sonic and visual possibilities of everyday objects, digital and analog visual components and hacked electronics." ; Doty, *The Just Intonation Primer : An Introduction to the Theory and Practice of Just Intonation*, 8."The simplest form of periodic vibration is a sine wave or sinusoid. Most acoustic instruments produce complex periodic vibrations that are the result of many pure tones vibrating together. Each vibrating pure tone within a complex tone is called a partial." Waniuk, "DMA Qualifying Exam. Question III," 4.

[171] Microscopy can be defined as "the technical field of using microscopes to view samples & objects that cannot be seen with the unaided eye (objects that are not within the resolution range of the normal eye)." "What Is Microscopy?," The University of Edinburgh, September 27, 2018, https://www.ed.ac.uk/clinical-sciences/edinburgh-imaging/for-patients-study-participants/tell-me-more-about-my-scan/what-is-microscopy.

[172] "The harmonic or overtone series is an ordered set of frequencies containing all possible integer (positive whole-number) multiples of a fundamental frequency. Component partials that are not integer multiples of a fundamental frequency are classified as inharmonic because they diverge from the harmonic series and create an aperiodic waveform. Inharmonic partials are commonly produced by percussion instruments such as bells, gongs or cymbals. Similar to the way that light contains all colors of the spectrum, a complex periodic vibration may contain many partials from the harmonic series." Waniuk, "DMA Qualifying Exam. Question III," 4–5.

[173] Kyle Gann, *Arithmetic of Listening: Tuning Theory and History for the Impractical Musician.* (University of Illinois Press, 2019), 20. Timbre is determined by the relative intensity/amplitude of the component frequencies of the harmonic spectrum of given sound or pitch (e.g. a flute will emphasize even partials while a clarinet will emphasize odd).

Metaphorical semantic crossmodal correspondences abound in musical terminology. For example: "soft" equates low volume with touch/texture; "high and "low" refer to pitch frequency and spatial elevation. *Within Worlds* explores semantic crossmodal correspondences linking "dark" and "bright" timbre with luminosity as well as correspondences between the acoustic phenomenon of "beating," "beating patterns" and "roughness" with visual texture.[174] Sympathetic vibrations and resonance are an important component of classical string technique and are closely linked to my understanding of timbre and sympathetic resonance as a violinist.[175] In the case of string instruments, sympathetic resonance or sympathetic vibrations occur when a bowed or plucked string causes one or more corresponding harmonics on neighboring strings to resonate: "the most resonant sympathetic vibrations on a violin will be produced by playing stopped notes that are of the same pitches as open strings, followed by their lowest harmonics - namely G,D, A, and E in different registers."[176] Amongst many implications of sympathetic

[174] Doty, 11.; Waniuk, 11–12. Measured in cycles per second, beats or interference beats, occur when two concurrent sound waves with distinct frequencies and/or amplitudes create alternating patterns of reinforcement and cancellation. Also referred to as amplitude modulation, beating manifests aurally as pulsations or periodic fluctuations in intensity. The closer two pitches get to unison, the slower the beating becomes. Beats are audible when the difference between two generating frequencies is less than 20-25 Hz.; Waniuk, 12. As the difference between two simultaneously sounding pitches increases, the beats "blend together, giving rise to a general sensation [called] 'roughness' [which is the product of rapid interference beats]. This roughness decreases as the difference [between discrete pitches] increases, persisting until the difference exceeds the critical band, which for most of the audio range falls between a whole tone and a minor third" Listening and adjusting for varying degrees of 'roughness' and interference beats is an essential part of the tuning process for any non-fixed pitch instrument or vocalist. Doty, 18.; Texture is a physical property that can be analyzed by touch (physical) or sight (visual). Liu et al., 2015 note that: "Physical texture is distinguished from visual texture by a physical quality that can be felt by touch (Manfredi et al., 2014). Jianli Liu, Edwin Lughofer, and Xianyi Zeng, "Aesthetic Perception of Visual Textures: A Holistic Exploration Using Texture Analysis, Psychological Experiment, and Perception Modeling," *Frontiers in Computational Neuroscience* 9 (November 4, 2015): 2, https://doi.org/10.3389/fncom.2015.00134.

[175] In the field of musical acoustics, resonance is defined as: "A large amplitude of oscillation built up when a vibrating system is driven by an outside periodic force of frequency close to a natural frequency of the system." Murray Cambell, "Resonance," Grove Music Online, accessed July 31, 2024, https://www.oxfordmusiconline.com/grovemusic/display/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000023236.

[176] Hans Jørgen Jensen, Minna Rose Chung, and Grigory Kalinovsky, *ViolinMind:Intonation and Technique* (Ovation Press, Ltd., 2019), 13.

resonance for string players is the fact that compositions in certain keys can highlight one or more open strings through their harmonic function, resulting in a "brighter" timbral effect. *Within Worlds* is structured around pitch relationships that invite performers to intuitively explore resonance, timbre, beating patterns, roughness and spectral content rather than linear harmonic progression. Musical material in the piece evolves subtly from quasi unison dyads to more complex pitch clusters centered around A 440 hz—the same frequency as the second open string on the violin. Pitches are suggested in the score, but I afforded performers the agency to choose from amongst distinct pitch groupings including microtonal options.[177] I wasn't interested in precisely tuned complex intervals per se, rather the possibility of various beating patterns arising and subsiding organically as a counterpart to evolving visual textures and patterns.

Sound waves can be sensed by the ear and felt on the skin via vibrotactile sensory receptors.[178] A familiar example would be experiencing bass frequencies via whole-body vibration at high sound level events (e.g. rock, pop, EDM concerts). Vibrotactile stimulation has also been proven to allow participants to discriminate between dark and bright timbre suggesting a further possible crossmodal correspondence between timbre, touch, and luminosity.[179] Russo, Ammirante and Fels point out: "Unlike visual cues, tactile information obtained from touching a stereo speaker or the soundboard of a cello consists of the same physical energy used by the

[177] In the Western contemporary classical music, tradition, the term 'microtonality' or 'microtonal' typically refers to using musical intervals that are smaller than the dominant 12-tone equal temperament system (e.g. any interval smaller than a semitone such as quarter tone).

[178] Kai Siedenburg et al., "Vibrotactile Enhancement of Musical Engagement," *Scientific Reports* 14, no. 1 (April 2, 2024): 1, https://doi.org/10.1038/s41598-024-57961-8.

[179] Frank Russo, Paolo Ammirante, and Deborah Fels, "Vibrotactile Discrimination of Musical Timbre," *Journal of Experimental Psychology. Human Perception and Performance* 38 (June 18, 2012): 822–26, https://doi.org/10.1037/a0029046.

auditory system."[180] Interestingly, although the frequency threshold for perceiving pitch difference is limited for vibrotactile discrimination vs hearing, both the ear and skin rely on mechanoreceptors to trigger neural impulses sent to the brain in response to stimuli.[181] As a violinist, I am intimately familiar with sympathetic resonances causing the strings under my fingers and the entire body of the instrument to vibrate subtly when bowing specific pitches.[182] Consequently, I suspect that my training has led to the cultivation of statistical crossmodal correspondences that bind pitch, timbre, touch (vibrotactile feedback) and by extension luminosity (e.g. greater resonance - greater vibrotactile feedback - greater luminosity) with amodal stimuli such as temporal patterning and intensity. When planning the score, I was cognizant of choosing pitches that had the potential to create various acoustic beating patterns, vibrotactile feedback and resonances to augment the idea of shared vibrations/oscillation between light and sound waves that has fascinated so many artists before me.

Within Worlds, uses simple graphic notation based primarily on shape-loudness crossmodal correspondences. Arranged on a timeline, the score consists of a series of symbols denoting relative duration, envelope and attack, alongside corresponding text instructions pertaining to pitch and timbre. Within a given temporal segment, performers are prompted to create a musical trajectory by choosing from the following options: graphic symbols (representing discrete sonic events), a collection of pitches (performers should ideally pick one pitch or dyad per graphic symbol) and/or instructions related to improvising using extended

[180] Russo, Ammirante, and Fels, 1.

[181] Razvan Paisa, Niels Christian Nilsson, and Stefania Serafin, "Tactile Displays for Auditory Augmentation–A Scoping Review and Reflections on Music Applications for Hearing Impaired Users," *Frontiers in Computer Science* 5 (April 27, 2023): 2, https://doi.org/10.3389/fcomp.2023.1085539.

[182] Waniuk, "DMA Qualifying Exam. Question III," 21.

instrumental techniques that result in complex and oftentimes unpredictable spectral material (e.g. air sounds, changes in bow pressure/contact point, whistle tones, split tones).[183] I used four categories of markings to denote sonic events; various thickness of lines, linear sequences of dots, irregular textural markings, and enclosed wedge-like shapes modeled on *crescendi/decrescendi*.[184] Rather than fill in the enclosed shapes with black ink or another color, I left them "empty" in order to let the decision of which pitch to play rest in the hands of the performer.[185] Like a conventional multi-part score—or as I like to think of it, geological strata — each segment consists of an irregularly staggered pattern of graphic symbols arranged on a vertical and horizontal axis. Rather than representing relative changes in pitch frequency or

[183] Space between symbols equates to moments of rest within the context of the score.; A variety of changes in timbre can be achieved by changing the contact point of the bow on the string (i.e placement of the bow relative to the bridge or fingerboard of the violin). To borrow from the language of semantic crossmodal correspondences, moving the bow further away from the bridge (aka *sul tasto* Italian for 'on the finger board') produces a "softer" or "less focused" timbre. Conversely, moving the bow closer to the bridge *sul ponticello*—typically results in a "stronger," "brighter" or more incisive quality to the sound. Depending on the amount of pressure, articulation and exact placement of the bow relative to the bridge, various harmonic partials of the fundamental can emerge, become suppressed or subsequently distorted. As violinists Patricia and Allen Strange remark: "Contemporary performers…have come to realize that the technique can yield a wide variety of timbres ranging from a slight coloration of the pitch to a complete elimination of the fundamental that produces a clangorous, almost non-descript timbre." Patricia Strange and Allen Strange, *The Contemporary Violin: Extended Performance Techniques , Patricia Strange and Allen Strange.*, The New Instrumentation 7 (Berkeley: University of California Press, 2001), 3. In my own improvisation practice, I find the wide spectrum of timbres available through micro-adjusting variables of bow speed, contact point and pressure—particularly with regards to *sul ponticello*— especially compelling to explore.; Sometimes called 'whisper tones' or 'whistle sounds'. Robert Dick describes whistle tones as: "individual partials of notes, are high, pure sine tones. They can be produced with every fingering, and, depending on the fingering used, from five to fourteen whisper tones can be sounded by forming a narrow lip opening and blowing as gently as possible across the embouchure. Whisper tones are heard only at extremely low dynamic levels and are difficult to sustain individually, for they have a strong tendency to oscillate one to another." Robert Dick, *The other flute: a performance manual of contemporary techniques , Robert Dick.*, 2nd ed. (New York: Multiple Breath Music Co., 1989), 132.;"Split-Tones - The Modern Trumpet by Nathan Plante The Modern Trumpet by Nathan Plante," accessed July 22, 2024, https://themoderntrumpet.com/2020/10/20/split-tones/. Split tones are an extended technique for trumpet whereby adjusting the embouchure results in the simultaneous sounding of two notes from the harmonic series.

[184] Please see the previous section for a discussion of the prevalence of this type of notation in 20th and 21st century contemporary classical and experimental music.

[185] After some consideration, I decided that adding color(s) would likely imply crossmodal correspondences between hue and pitch. Even considering the fact that mappings would be inherently individualistic, I wanted to ensure that performers had freedom to determine their own musical trajectory with regards to pitch choice—not only in relation to themselves and other participating performers, but ultimately in the context of the fixed audio as well.

instrumentation (e.g. higher on page equates to higher pitch), the vertical space is intended to reflect the potential for multiple overlapping sonic events to occur over the course of a performance. Performers are free to move between strata as long as the relative duration of sonic events corresponds to the indicated time frame (see Figure 1.7).

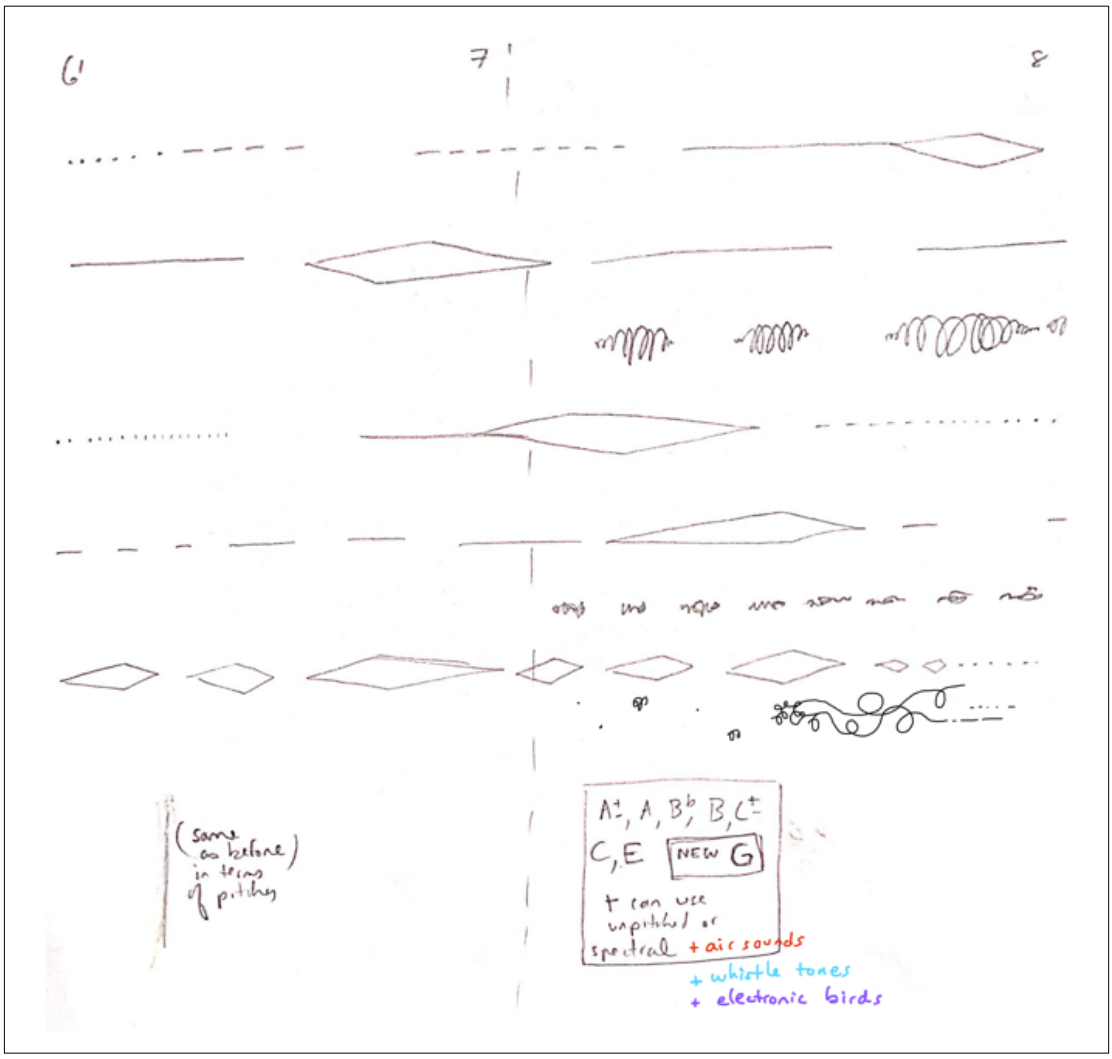

Figure 1.7: Score excerpt from Within Worlds (2022)

To create the fixed media component of *Within Worlds*, each member of in^set recorded two separate passes through the score.[186] Using Ableton Live, I layered and manipulated the six raw audio files into a single stereo file by cutting, splicing and adding simple effects such as panning, echo, delay and reverb. Once the audio was finalized, I worked together with fellow in^set member, Teresa Díaz de Cossio, to create abstract macro video footage of our respective instruments (flute, trumpet and violin) using an inexpensive digital microscope,[187] prism lenses designed for novelty photography, colored gels and LED lights (see Figure 1.8).

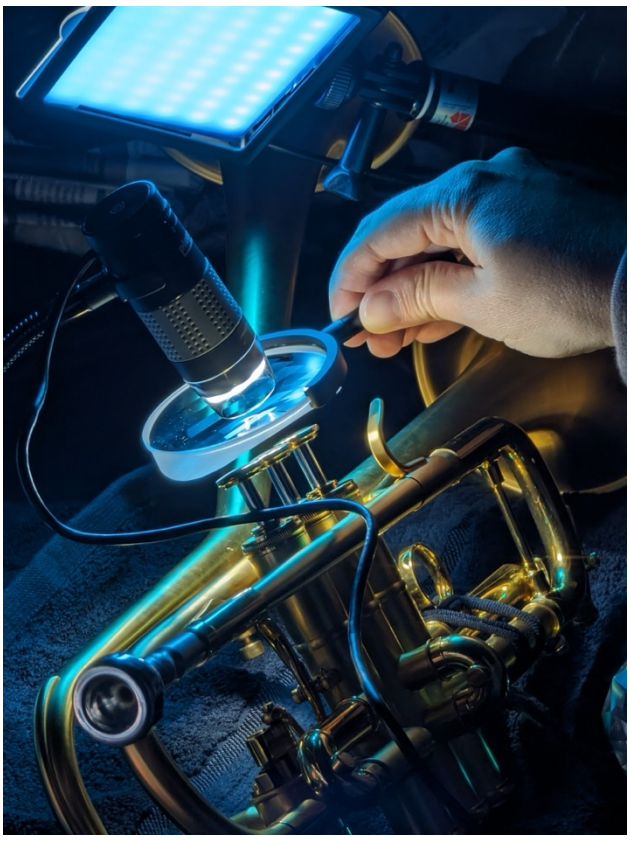

Figure 1.8: Close up of set up for improvising video footage using a digital microscope, LED light, prism lens and double bell trumpet. Photo credit: David Aguila

[186] Performers were instructed not to listen to playback of previous takes when undertaking the recording process.

[187] Pluggable Digital Microscope with Flexible Arm Observation Stand Compatible with USB and USB-C Windows, macOS, ChromeOS, iPad (USB C), Android, Linux Systems (2MP, 250x Magnification)

While listening to the fixed track we improvised real time changes to several visual parameters in response: adjustments in focus, changes in camera position (to capture various close-up details of the instruments) and shifts in hue via colored lighting gels and LED lights. We undertook two fully improvised takes per instrument resulting in the equivalent of six video files, each corresponding to the length of the audio track (see Figure 1.9).[188]

Figure 1.9: Ilana Waniuk (left) and Teresa Díaz de Cossio (right), improvising video footage for Within Worlds. Photo credit: David Aguila.

While Díaz de Cossio and I did not set out to explore specific audiovisual crossmodal correspondences during our improvisations, upon reflection, some possible crossmodal correspondences we employed included: emotion, hue and pitch (using different colored lighting

[188] Due to issues with the battery life of the digital microscope during filming, some full takes were completed in two or more shorter segments.

gels to reflect various emotional responses to changes in pitch material); pitch and brightness; timbre and saturation (using rudimentary shifts in manual focus and proximity of camera lens to object to respond to changes in timbre); matching density of visual texture to musical texture (corresponding increases/decreases); temporality (e.g. matching the duration of an isolated visual parameter to that of a particular audio component). Mirroring the process of creating the fixed audio,[189] I compiled and edited the recorded visual improvisations to match the duration of the fixed audio using Premiere Pro. When creating the fixed media, I was most interested in exploring visual texture through layering video clips and experimenting with blend modes.[190] I wanted to create a series of shifting textures and abstract patterns inspired by my crossmodal impressions of the fixed audio track.[191]

During performance, flute and violin perform from the score in tandem with the fixed media track and are amplified via DPA microphones.[192] Audio from flute and violin is further processed using Ableton Live and manipulated by a third performer who is responsible for

[189] Grayson Cooke, "Improvisation in Live Audio-Visual Performance," *Screen Sound Journal*, 2011, 24. Digital software for audio and visual media editing share many similar traits and processes. Both are frequently timeline based and allow artists to work with digital content using roughly analogous techniques such as layers, loops, effects and various filters. Cooke notes that digital tools treat "sound and video as made of the same stuff." For example, DAW software uses visualizations of audio files—reflecting the amplitude and frequency of the complex waveform—to provide users with a means of manipulating and reconfiguring material on a timeline. A comparable process to arranging and editing digital video files in software such as Premiere Pro or Final Cut.

[190] Paul Barnes-Hoggett et al., "Blending Modes," in *Flash 8 Essentials* (United States: Apress L. P, 2006), 20. Blend modes or blending modes are a tool used in digital image/video editing software to combine two images or video clips into a hybrid image by employing a series of set calculations using pixel color values from each original image. Blend modes have become ubiquitous in many popular video and image editing software programs (e.g. Adobe Photoshop, Premiere Pro, GIMP, DaVinci Resolve).

[191] Please see file 1A.WithinWorldsExcerpt.mp4 for a sample of the fixed media that is used during performance.

[192] A cloud synchronized stopwatch and timer is used to synch up the performance within the fixed media. https://www.chronograph.io/eqFCa8YR

adding effects to the live audio signals and for mixing fixed and amplified audio in real time.[193] In order to support the illusion of being immersed in a complex soundwave, *Within Worlds* should ideally be performed with each of the three performers situated at vertices of an equilateral or isosceles triangle surrounding the audience (see Figure 1.10).

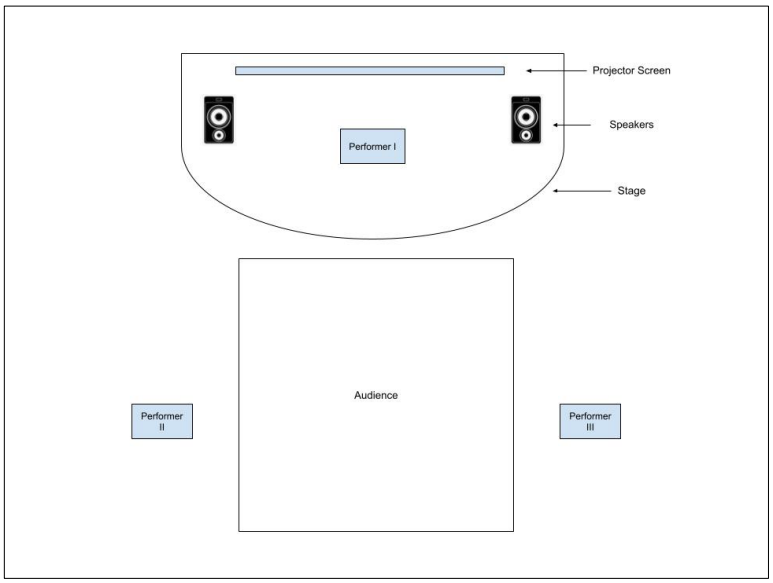

Figure 1.10: Staging Diagram for *Within Worlds*

The apex of the triangle is located downstage center and is occupied by Aguila, who sits at a table in front of the projector screen with laptop and midi controller.[194] Fixed audio is played using stereo speakers situated at the front of the house. Bearing in mind ease of setup and cost efficiency, I designed *Within Worlds* to be able to be performed in any venue that has a simple stereo audio speaker setup. My intention with physically spatializing the performers was to emulate more complicated surround sound speaker configurations. To ensure vibrancy and

[193] David is instructed to choose from effects such as reverb and/or delay and to improvise freely with various effects parameters over the course of the performance (e.g. decay time, size, blend, dampening and stereo) in response to the live and fixed audio.

[194] Audio effects are mapped to a midi controller to facilitate ease of performance.

sharpness of the projected image, the performance space should be kept relatively dark. Just prior to the start of the piece, the flute and violin enter unnoticed and remain in the dark for the duration of the performance (see Figure 1.11).

Figure 1.11: Flutist Teresa Díaz de Cossio (top) and violinist Ilana Waniuk (bottom) performing Within Worlds. California Festival: A Celebration of New Music, part of Project Blank's Salty Series. Nov 17th, 2023. Bread and Salt, San Diego, CA, U.S.A. Photo Credit Robbie Bui[195]

[195] For the Nov 17th performance, I experimented with adding an additional layer of audio using tape recorders, and mini amps (pictured above) with built in delay and overdrive effects. I made two individual tapes using supplementary recordings of the score by Aguila and Díaz de Cossio which centered 'noise' and extended techniques rather than pitched material. During the performance, Díaz de Cossio and I had the option to freely manipulate various parameters of the tape recorders in addition to using our instruments. Ultimately, I felt the addition of tape ended up detracting for our ability to create beating patterns with each other and the original fixed audio track using our instruments and have since abandoned this approach.

Ideally, the focus of audience members should be drawn to Aguila and the screen at downstage center (see Figure 1.12). As the piece progresses, variation in pitch and timbre between spatialized acoustic and amplified signals create opportunities for audience members to experience singular location dependent beating patterns and unplanned audio artifacts, hopefully aiding in the crossmodal illusion of being immersed in vibrations of a soundwave, a beam of light or at the very least in a site-specific multisensory experience.

Figure 1.12: David Aguila performing live electronics for Within Worlds. California Festival: A Celebration of New Music, part of Project Blank's Salty Series. Nov 17th, 2023. Bread and Salt, San Diego, CA, U.S.A. Photo Credit Robbie Bui.

Chapter 2 INTERVIEW

2.1: Alive Painting

> I am a painter.
>
> I would like to paint living things and convey energy metamorphosis […]
> Combining the energy of movement and the vibrant of colors, I bring pictures to life.
> I depict the resonance between shapes and textures by using different types of liquids, each with a unique characteristic.
>
> How the materials interact with each other is influenced by external factors, such as wind, sound, humidity, gravity, time…etc.
>
> —Akiko Nakayama

I first encountered Japanese artist Akiko Nakayama's liquid visual practice in 2018. At the time, I was researching contemporary Canadian and Japanese artists to participate in a music festival in Tkarón:to (Toronto) through my role as co-artistic director of Thin Edge New Music Collective (TENMC).[196] Japanese-based Canadian composer Daryl Jamieson, introduced me to the video linked in the footnote below— a recording of an improvisation featuring visualist Nakayama, Ko Ishikawa (shō) and Ami Yamasaki (vocals). I was immediately captivated by the way Nakayama's visuals were integrated organically into the fabric of the ensemble performance.[197] In particular, the way in which she created dialogue with her fellow improvisers through pacing, gesture and the textural complexity of her materials —typically liquids of

[196] TENMC's ONGAKU festival—roughly translating to 'noise' in Japanese— took place in Tkarón:to between September 20-22, 2019. TENMC performers were joined by guest artists Miyama McQueen-Tokita (bass koto), Ko Ishikawa (shō), Ami Yamasaki (voice) and Akiko Nakayama ('alive painting'), as well as Tkarón:to -based Urbanvessel, featuring Germaine Liu (percussion), Aki Takahashi (shamisen/voice) and Sonja Rainey (projections/installation). ONGAKU featured world premieres by Canadian composers Hiroki Tsurumoto, Juliet Palmer, Daryl Jamieson alongside new works by Yuka Shibuya, Takeo Hoshiya, and the Canadian premiere of compositions by Toshiya Watanabe, Yoshiaki Onishi, Jo Kondo, Malika Kishino, and Miya Masaoka.

[197] https://youtu.be/a3OqH7ffX2s?si=uJgZkK95Gb8ZnCsm

varying viscosities and opacities.[198] After extending an invitation to perform with Ishikawa and Yamasaki in Tkarón:to as part of TENMC's ONGAKU festival, I was thrilled when Nakayama accepted our offer and agreed to add an additional performance consisting of improvised visuals for Miya Masaoka's string quartet, *Partial Eclipse* (2018).[199]

Nakayama coined the term "Alive Painting" to describe her particular take on improvising with liquids. One which relies on a digital camera rather than an overhead projector. Nakayama describes the process of "Alive Painting" as a:

> painting of dynamic changing scenery by painting and sounds. During the performance, people and the painter concentrate on the characteristics of water and the effect of color. And they feel the philosophical meanings of colors, shapes, and movement. These works exist for the briefest of moments before changing into something new, constant evolution from one form to another and constantly shifting, always changing, always beautiful.[200]

Her performance setup involves a high-resolution projector, live camera feed with macro lens, and adjustable light source to illuminate a raised working surface (see Figure 2.1). Approximating the size and shape of a classroom overhead projector, the surface (or stage) that Nakayama uses for manipulating liquids is compact but configurable, so that she can alter the angle in order to allow gravity to impact the flow of materials during performance. She works with droppers, paint brushes, and spray bottles in combination with paints, inks, and various other fluids, often relying on physical properties of liquids to structure her improvisation (e.g.

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[198] In addition to liquids, Nakayama also often incorporates organic matter, still images and found materials in her work.

[199] See File 2A for a video clip featuring live visuals by Nakayama with an excerpt of Miya Masaoka's, *Partial Eclipse* performed by Ilana Waniuk and Suhashini Arulanandam, violins, Amahl Arulanandam, cello and Aysel Taghi-Zada, viola. Recorded on September, 20th, 2019 at 918 Bathurst in Tkarón:to, ON, Canada. Audio recorded and mixed by Kai Masaoka with videography by Timothy O'Reilly. Interestingly, due to the stage set up, and the fact that we were performing from a score, I wasn't able to see the visuals Nakayama created until viewing the recording several weeks later. As such, this particular collaboration felt a bit disconnected from my perspective as a performer, though from what I understand this was not the case for audience members.

[200] Nakayama, "2024."

ferrofluid, carbonated water) (see Figure 2.2).[201] When touring, she frequently searches for new materials and liquids unique to each locale. Her Tkarón:to performance was no exception, in an email correspondence prior to her performance she remarked: "I will bring materials, but it is really nice to find new paints in Toronto."[202]

Figure 2.1: Performance setup for Akiko Nakayama. Photo credit, Thanyarat Photography.

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[201] "Ferrofluid is made of tiny, nanometer-sized particles of coated magnetite suspended in liquid. When there's no magnet around, ferrofluid acts like a liquid. The magnetite particles move freely in the fluid. But when there's a magnet nearby, the particles are temporarily magnetized. They form structures within the fluid, causing the ferrofluid to act more like a solid. When the magnet is removed, the particles are demagnetized and ferrofluid acts like a liquid again." "Schubert.Ferrofluids.Pdf," accessed August 8, 2024, https://ncmn.unl.edu/outreach/images2/Schubert.Ferrofluids.pdf.

[202] Akiko Nakayama, email correspondence with the author, August 10th, 2019.

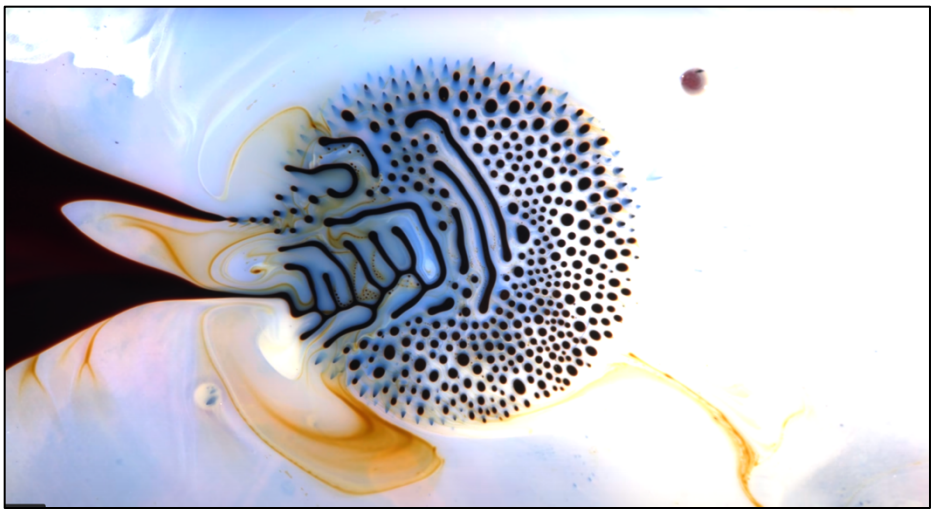

Figure 2.2: Still from Akiko Nakayama 8K studies, showing an example of ferrofluid (dark liquid) in combination with other inks and paints.

Nakayama has collaborated with musicians working in a wide range of musical styles from free improvisation to electronica to jazz, pop and classical music. She also cultivates a solo audiovisual practice, in which she uses specially designed software: "a color-organ system called 'Fluid2wave [...] This system uses soundtracks and sound effects to accompany the digital projection of the live color painting."[203] During our interview, I asked her about the musical materials involved in Fluid2wave. She explained that the program functions like a library of field recordings, drones and sound collages. Nakayama first collects and creates audio materials to feed into the system, then, during performance, triggers sounds and various audio effects using a midi controller so that her hands remain free to improvise. Nakayma's compelling use of gesture and phrasing, both as a soloist and in group setting, could be an extension of having played bass guitar in a band with friends during her teen years. Or, equally likely, it could be a skill honed as a result of over a decade of artistic research in collaborative audiovisual performance.

[203] Nakayama, "Statement."

Scientific processes such as fluid dynamics and cymatics are a recuring theme in Nakayama's work. Nakayama has recently collaborated with researchers at the Okinawa Institute of Science and Technology (OIST) on a project investigating the physics behind dendritic patterns.[204] Following in the footsteps of artists David Alfaro Siqueiros (1896-1974), Jackson Pollock (1912-1956) and Naoko Tosa (b. 1961), who explored various aspects of fluid mechanics in their work, the OIST lab is dedicated to reproducing and studying these techniques in order to "understand how the characteristics of the fluids influence the final outcome."[205] Dr. San To Chan and Professor Eliot Fried were particularly interested in an approach Nakayama uses whereby acrylic ink thinned with isopropyl alcohol is dropped over a layer of acrylic paint "yielding intricate tree-like dendritic patterns. [Which] exhibit several textural characteristics. The dendrites are of diverse sizes and predominantly exhibit self-avoiding tendencies without intersecting. While some of their edges are blurred, others are more clearly defined," (See Figure 2.3).[206]

[204] The word "cymatics" was coined by Hans Jenny in 1967. "Cymatic means «matter related to waves». Cymatic drawings are images of sound. The higher the frequency, the more complex the figures… comparable to the mandala, [or] geometric patterns used in meditation and rituals of many spiritual practices […] Jenny's work was based in part on the research of Ernst Chladny, who in 1787 repeated Robert Hook's 1680 work to show the…[patterns] created by sand placed on a metal plate [and] vibrated by the sound of a violin bow. The sand formed what is now called a permanent wave pattern..." Gao Yun and Xia Jiali, "Research and Exploration on Cymatics in Sound Visualization," *E3S Web of Conferences* 486 (2024): 3, https://doi.org/10.1051/e3sconf/202448603002. See French/American duo *Shapes of Emergence* for a current example of cymatics, live music, and microscopy in performance: https://www.shapesofemergence.com

[205] "Beyond the Ink: Painting with Physics," Okinawa Institute of Science and Technology OIST, February 29, 2024, https://www.oist.jp/news-center/news/2024/2/29/beyond-ink-painting-physics.

[206] San To Chan and Eliot Fried, "Marangoni Spreading on Liquid Substrates in New Media Art," ed. Gary Grest, *PNAS Nexus* 3, no. 2 (February 1, 2024): 2, https://doi.org/10.1093/pnasnexus/pgae059.; For a video demonstrating the process of Margoni spreading please see the following link. *Marangoni Spreading on Liquid Substrates in New Media Art*, 2024, https://www.youtube.com/watch?v=r_7unYKX_zc.

Figure 2.3: Akiko Nakayama manipulating fluids to create dendritic patterns. Photo credit the artist.

Through my interview, I learned that prior to studying art at Tokyo's Zokei University, Nakayama had considered becoming an arborist in order to understand the "why" behind certain biological processes, particularly those involving colored liquids. She continues to hold a deep respect for scientific inquiry, a sentiment Nakayama echoes in an article discussing the OIST collaboration: "I was very happy to be contacted by OIST physicist Chan San To. I am envious of his ability 'to dialogue' with the dendritic patterns, observing how they change shape in response to different approaches. Hearing this secret conversation was delightful."[207]

[207] "Beyond the Ink."

2.2 Light Shows

Nakayama's "Alive Painting" while focused on painterly techniques and the physical properties of liquids themselves, follows a rich tradition of improvised collaborative live visuals using liquids and other media. In the Fifties, San Francisco-based artists Harry Smith (1923-1991) and Jordan Belson (1926-2011) began creating abstract visuals which they would later manipulate in various ways in real time to accompany live music performances. Smith and Belson's experiments using multiple projectors and improvised visuals paved the way for psychedelic light shows of the 60's. Light shows—sometimes called liquid light shows—became synonymous with rock concerts of the late sixties and were typically performed by collectives of artists. Much like the bands they played alongside, improvisation was an essential component of the creation process for groups such as Joshua Light Show and Single Wing Turquoise Bird (SWTB). SWTB member Peter Mays described the experience of collective creation:

> Working with a group there's a whole different kind of feeling, a kind of communication, a collective vision and meaning that's like Hermann Hesse's idea in *The Glass Bead* Game- taking everything in all cultures and communicating comprehensively on all levels of society simultaneously. In a sense that's what the new consciousness is about, comprehensive living. Our language definitely is anti-Minimal. It's a reaction to Minimal Art just as Minimal Art was a reaction to the complexities of Jackson Pollock's Abstract Expressionism. We're making Maximal Art.[208]

Ensemble members relied on intricate systems of overhead projectors, further modified by lenses, mirrors, color wheels and custom-made devices to manipulate a variety of materials ranging from 16 mm film and prepared slides/transparencies to colored oils/dyes and chemicals.[209]

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[208] Gene Youngblood, *Expanded Cinema* (E.P Dutton & Co., Inc., New York, 1970), 396.

[209] Amy Alexander and Nick Collins, "Live Audiovisuals," in *The Cambridge Companion to Electronic Music*, ed. Julio d'Escrivan and Nick Collins, 2nd ed., Cambridge Companions to Music (Cambridge: Cambridge University Press, 2017), 127, https://doi.org/10.1017/9781316459874.009.

Los Angeles-based, SWTB developed a working method using techniques from avant-garde film, liquids, multiple projectors, strobe lights and animation. Unlike most other light show artists of the time, SWTB, gradually shifted their performance milieu away from rock concerts towards art galleries, and museums, often using tapes and records during performances or creating their own sound sources.[210] Gene Youngblood described SWTB's unique take on live visuals as: "a combination of Jackson Pollock and *2001,* of Hieronymus Bosch and Victor Vasarely, of Dali and Buckminster Fuller. Time-lapse clouds run across magenta bull's -eyes. Horses charge in slow motion through solar fires. The hands of a clock run backward. The moon revolves around the earth in a galaxy of Op Art polka dots."[211] In New York, Andy Warhol's Exploding Plastic Inevitable (EPI), stands in stark contrast to the predominant counterculture aesthetic of most 60's Light shows which celebrated values of "communal harmony and cosmic consciousness."[212] EPI primarily used strobing effects, lighting and projections of Warhol's films, with live music by The Velvet Underground and Nico. The Velvet Underground— whose songs prominently featured noise, and feedback— perfectly exemplified the difference between EPI and other light shows by performing songs "about the wrong drugs: not the beatific allusions inspired by marijuana and LSD, but the desperate void created by heroin."[213] Joshua Light show, perhaps the best-known ensemble, was in residence at the Filmore East Auditorium from 1968-1971, creating visuals for artists like Janis Joplin, The Jimi Hendrix Experience and The Doors

[210] Brougher, "Visual-Music Culture," 166; Alexander and Collins, "Live Audiovisuals," 128.

[211] Youngblood, *Expanded Cinema*, 394.

[212] David E. James, "Light Shows and Multimedia Shows," in *See This Sound: Audiovisuology Compendium*, ed. Dieter Daniels, Sandra Naumann, and Jan Thoben, 2010, 183.

[213] John P. Gelinas, "It Happened in 1966: Andy Warhol's Plastic Exploding Inevitable," accessed August 8, 2024, https://msmokemusic.com/blogs/mind-smoke-blog/posts/6563673/1966-any-warhol-s-plastic-exploding-inevitable.

(among others). JLS featured up to ten members in a given performance and used multiple projectors, color wheels, lights, and liquids, as well as explorations in refraction/reflection dubbed Lumia in honor of Thomas Wilfrid.[214] Zinnman describes the complexity of JLS's set up at the Filmore:

> The group employed a panoply of image-making apparatus to achieve diverse visual effects: three film projectors, two banks of four-carousel slide projectors, three overhead projectors, hundreds of color wheels, motorized reflectors made of such materials as aluminum foil, Mylar, and broken mirrors, two hair dryers, watercolors, oil colors, alcohol and glycerin, two crystal ashtrays, and dozens of clear glass clock crystals. White and his cohort designed a rear-projection system, situated roughly twenty feet behind the Fillmore stage, where several tons of equipment was arrayed on two elevated platforms.[215]

In England Joan Hills and Mark Boyle took a more experimental and visceral approach to the Light Show as exemplified by their performance *Son et Lumière for Bodily fluids and Functions* (1966) which incorporated bodily fluids such as sweat, urine, blood, and sperm.[216] Similarly, *Son et Lumière for Earth, Air, Fire and Water* (1966) relied on the various physical and chemical properties of liquids themselves. Gregory Zinnman explains:

> Boyle and Hill [engineered] a series of chemical and physical reactions related to the four elements. These reactions, made without additional stirring or mixing by the artists, were projected on screen in real time, accompanied by the amplified sounds of the process. Rocks and sand were corroded and crystallized, materials were set ablaze, air was pushed through liquids, ice was melted, and water boiled. Later performances made use of multiple screens, which would show the

[214] Abbado, *Visual Music Masters: Abstract Explorations: History and Contemporary Research*, 31. In 1922, Thomas Wilfrid (1889-1968), developed a silent light instrument called the Clavilux. Wilfrid didn't believe in the physical equivalence of light and sound and used the term "lumia" in order to differentiate his work from that of other color organs that used sound. The Clavilux resembled a large cabinet. Inside, various colored glass discs and devices such as glass tubes and reflective surfaces were designed to manipulate incandescent light via a system of gears, and pulleys which controlled the motion and position of various components.

[215] Gregory Zinman, "JOSHUA LIGHT SHOW 1967-68," 2012, https://www.joshualightshow.com/about-classic/joshua-light-show-1967-68.

[216] James, "Light Shows and Multimedia Shows," 179.

> "induced reactions" in color and "observed phenomena" in black-and-white on another.[217]

The decline of counterculture values in the 1970's meant that lightshows fell out of fashion, only to experience a resurgence with the rise of rave culture in the 1980's and 90's. That being said, since the 60's, Light Show traditions and techniques have been preserved through bands that celebrate psychedelia like The Grateful Dead. As Spinrad notes, Light Shows themselves became "a visual shorthand for the era as a whole."[218] Today, the Light Show tradition continues, partly as a means of nostalgia but also, increasingly, a new generation of artists is interested in exploring the medium both for its expressive and ephemeral qualities. While Nakayama's practice is centered around the use of liquids in a live performance setting—drawing clear parallels to the lineage of light shows, "Alive Painting" stands apart from these traditions through her collaborative but fundamentally solo improvisatory practice (rather than a team of visualists such as Joshua Light Show), use of a digital camera with macro lens, and focus on the fluid dynamics of liquids rather than layering of liquids with multimedia elements.[219]

Interview

This interview was conducted on June 20th, 2024 between Akiko Nakayama and Ilana Waniuk. The following excerpt has been edited for grammar and concision.

> **Ilana Waniuk:** First off, thank you so much for meeting with me. I'm honored to be able to speak to you about your work. My first question is: how did you get started doing live visuals? I was looking through your website and at your artist

[217] "Boyle Family," *Handmade Cinema* (blog), accessed August 8, 2024, https://handmadecinema.com/filmmaker/boyle-family/.

[218] Paul Spinrad, *The VJ Book: Inspirations and Practical Advice for Live Visuals Performance* (Los Angeles, CA: Feral House, 2005), 20.

[219] While Akiko sometimes incorporates still images (e.g. photographs) into her liquid visuals she primarily works with inks and liquids in her live practice.

statement, and you said that you were inspired to start "Alive Painting" to bring pictures to life. I was curious if there were any artists or artworks that inspired you to begin exploring this particular kind of medium?

Akiko Nakayama: Hmmm…Because I have 3 or 4 essential memories inside my brain about how I started "Alive Painting." When I was in Primary school, 3rd grade, I think. I wanted to be an arborist, a tree doctor, because I really like the mystery of colors of the plants. For example. You know the color of spinach? The bottom of the spinach is red, and then it gradually turns green.

AN: I asked myself "it is the big mystery of the spinach because why does some nutrition bring color and some just bring water inside the spinach?" For example, a dandelion also has a gradation of color inside. So, all around me, I had a great gradation of water and living inks inside the plants.

AN: Growing up in the city, I was very curious about plants. So, naturally, I wanted to be an arborist, but, while my curiosity for knowledge was increasing on the doctor side of the plant, my body had a lot of experience depicting my thoughts using drawing. Drawing something or writing something. So, in a way my body was the egg of the artist, but my thoughts and curiosity *was* the arborist. So, I had a little bit of a conflict.

AN: But when I went to the Art University. Naturally technique and curiosity become one. So, I started color gradation using water and paint and tried to figure out how to draw something as a living expression using painting. Does it make sense?

IW: I think so. It was really that your different interests in nature and in visual arts were important. It wasn't people doing liquid light shows or other kinds of live visuals that inspired you necessarily.

AN: It was my past concept and my past experience of figuring out what interests me and what I like. Also, maybe more on the technical side, but when I was at university, in first or second year, I collaborated with a university friend. She is a dancer, and there were many musicians around. So, I also collaborated with musicians and DJs.

AN: That is the first part of story. Then, later, hanging out in the bar, my friends started to think about what a new kind of performing arts could be…And then, they had an inspiration: "How about light painting as a group together with dance and music?"

AN: They knocked on the door to my studio, and asked me and I said, "yes!" So, then I started light painting using the video camera and video projector as a medium between dance— the dancer's body— and the music. Yeah. And then

for four, five and six years, we performed as a trio at the university festival as well, and, also, gradually, started to perform outside of the university.

AN: Then, I had an opportunity to collaborate with a many jazz musicians in Tokyo. That's when I realized that a great musician is someone who can not only be a great drummer in a group, but also present a great solo performance. So, I looked back at my own work. I thought I could work well as a medium to connect between dance and music through my visuals. I could also function well doing visuals in a group setting with jazz musicians. But could I do a great solo performance on the stage? So, that idea motivated me to start experimenting with solo performance after I graduated from university.

IW: And, when you started the solo performance, did it have sound? Was it the Fluid2wave program? Or was that later on?

AN: It was almost at the same time as the Fluid2wave program was developed with a programmer. But actually, for the first solo performance, I just used Ableton Live. And then, I made a layer of field recording sounds. And some simple beats and noise and drones, produced by me. And then at that moment, I started just thinking about how to make some of the music respond to the environment I was creating on the stage.

AN: Then I started working with Fluid2wave which uses a midi signal. I used a video camera during the live performance, and then a video camera to record. This camera sends a signal into my PC, and then my PC has a signal to wave application. Then a sixty-four color signal input for my PC, and those sixty-four signals become sixty-four midi buttons that I can assign to different parameters, presets and use to trigger clips in Ableton Live.

IW: So, with the Fluid2wave, was the audio being triggered in Ableton, the same kind of audio that you had mentioned before? Field recordings and drones that you made but that were triggered through midi?

AN: Yeah. Also, [through Fluid2wave] I can trigger effects in the Ableton Live's parameters that can be very precise. So, for example, if I use [the color] white, it can suddenly trigger the sound of a river, or something like that. But naturally [using Flued2wave], it felt totally different from the experience of collaborating with other musicians

AN: In answer to your next question.[220] The difference between solo and collaboration. It's a big difference! how about you? It is totally different for me. Probably, I think, with other artists it is very different too.

[220] I had supplied Akiko with a list of 12 questions prior to our zoom interview. The question she is referring to here is: Can you describe any differences in your performance practice between solo and collaborative performances?

AN: In solo improvisation performances, even if I don't use any storytelling footage or recognizable imagery during performance. I need to focus on what metaphor appears right now [in the moment of performance] with the abstract phenomena I'm creating.

AN: And, also, it's like live cinema or live storytelling —bedtime storytelling. I need to find ways to change the mood and sound in real time. Improvising in collaboration with other musicians is, more like, living architecture. For example, the musicians create a sound structure. The bass drum is like, stones. The bottom of the castle maybe, and something like, maybe the techno beats are like statues. Together they make, moving architecture with speed and time. So, it's totally different [than improvising alone]. So suddenly, the sound of the castle makes amazing, ambiguous structures on the stage, and then it's destroyed and created again. When improvising in collaboration with others, I need to focus on what's going on in the structure with the sound materials. My focus is mainly on making shapes and colors in a physical way.

IW: Thank you! It's funny because I often think that playing from a score — actually I think about that when improvising in an ensemble too— but when I'm performing, I often feel like playing from a score feels like building something from an architectural plan. You make strange buildings out of sound that just exist for a moment. I really like that you use that analogy. That's beautiful.

AN: Yeah. And, also, it is a great adventure to work with musicians. For example, the solo musician with a solo visual artist, me. It's like a duo, an adventure duo in the rain forest or something like that, or a new planet. Sometimes [when collaborating] I imagine new strange fruits on this planet. The juicy fruits swelling with the melodies of the musician. And then I have a feeling in response to the music and I create a new landscape with my visual techniques. So, it is a total adventure.

IW: I've been doing research into live visuals, and light shows and I've experimented with some techniques in my own practice too. What I love about your work is that you create layers of varying transparency and opacity using primarily the liquids themselves. Since you use the camera and not the overhead projector, you can rely on different types of interactions between the liquids because the light is not passing from the projection stage through liquids in the same way that it would using an overhead projector. I was curious how you started to work with materials in this way and what inspired you to begin exploring these kinds of techniques?

AN: Well, another thing that happened while I was at university. I started "Alive Painting" using a video camera with a macro lens. But, at the same time, I also studied Art history. And then, at that time, I was curious about visual artists using science, order and physics. I was interested in Goethe —who did a lot of

experiments about color theory —but also poems and music. So, he showed me that science and physics and the art is like [moves right arm and then left arm miming walking movements] left leg and right leg, and together they walk.

AN: Yeah. So, if I want to walk longer, I need to get another leg like them. So, I started to think about disassembling my "Alive Painting" practice into different parts. Like fluidity and color and metaphor. And then, for the science side of my "Alive Painting" I needed to connect with science, to get more of an understanding of the theory or the physics of liquids, and their characteristics. Then naturally, I learned the first steps of physics and fluid dynamics.

AN: Then recently, I researched with OIST University, the Okinawa Science University, about the dendritic effect of certain liquids used in combination with other liquids.

IW: Yes! I saw that article on your website. Their work is really amazing!

AN: Yeah. They are amazing! So, yeah, the entrance to these experiments was through my artwork, my artistic research through experimentation and performance. But now I also have an entrance to see the effects of the phenomena, from the science entrance, and also the art entrance.

IW: I'm curious how you came to incorporate liquids that aren't traditional paint or inks into your work. For example, ferric fluid. Did you find these liquids through research and then experiment with them visually?

AN: Yeah. I use that [in reference to ferric fluid].

IW: How did you, decide to start incorporating it in your work? Or how did you find out about it in the first place?

AN: I don't know if it's only in Japanese culture or not. But in the summer vacation it is too warm to study in the primary school. So, we have almost one month and a half summer vacation, and then, a lot of homework. But for example, the mathematics homework is simple. You just write down the answers, but there are more creative kinds of homework, like science research. And many parents and kids use science kits that appear in the summertime during this time to do these. You'll find them in the shops and supermarkets.

AN: So, at that moment, I often go there, and pick up some easy science effects kits. That's when I first found the ferrofluid, a tiny bottle of liquid ferrofluid, and I started to play with that. So that's kind of the easiest step [finding the materials]. Also, accidentally, my desk [in my studio] right now is super messy with many lipids and oils so naturally, through this mess, new combinations of liquids have a chance to meet each other—liquid and liquid.

IW: With the dendritic painting technique, was that something that also came about through playing and experimenting?

AN: Most of the time, new visual techniques have come about as a result of having to do long performances with musicians. Like, three or four hours DJing or one hour and a half.

AN: For example, if the first set is an hour and a half, and the second set is a one-hour jazz performance with a musician. I need to go to new horizons with the techniques to show different musical characteristics. Especially because I am playing for such a long time. So, for new adventures with only my prepared techniques and liquids even if I map out plans, I still need ways to find somewhere new to go if needed. Also, the musician and I both need flexibility and options to create new kinds of expression.

AN: So that kind of collaboration, an improvised collaboration that lasts a long time, is a place where I often encounter new phenomena like dendritic painting.

IW: Thank you! For my next question, could you speak a bit about how you prepare for performance? Do you pre-plan any elements? I guess sometimes that must depend on the context.

AN: Hold on…[bends down to pick something from her desk]... During performance, I have limited gigabytes of space in my "performance brain" to make active decisions. So, if I use a lot of different inks, the capacity of the area gets full immediately… So instead, I pick up 2 boxes with inks….[raises two separate tin boxes filled with a various inks]..... Each is like a baseball team. Most of the time, one tin is the first player of the baseball team, and the other is on the bench. Mhmmm..

AN: And, of course, a star player —like ferrofluid—It is unique and unchangeable, a unique player. Also, so are some of the lead inks and gold sparkles. It's like a team. And, also, the team is corrected as I go depending on the mood of the live performance.

AN: Also, if the musician has a script or the music has lyrics, something like that. If the theme of the live performance is the seaside, I might pick up the first team, the blue, gold, green, transparent mediums team. But if it is noise music or 100% improvised jazz collaboration, I can pick up some more crazy stuff, like that kind of Petri dish…[raises up a petri dish with crystalized liquid and texture left over after another liquid evaporating]...Yeah. It's a little bit noisy, but it makes an interesting effect…[raises up other petri dishes, small plates and plastic lids with dried up layers of paint that form different textural surfaces].

IW: Wow! Do you always use a macro lens with your camera?

AN: My canvas is like this. Yeah. [Holds up plate and gestures to a small area in the center —approximately 1.5 inches square] So it's too tiny. Because otherwise there is too much chaos, too much physics happening inside the Petri dish. So, I need to focus on only a few phenomenon inside the projection. Because the music is also like that. Too many uncontrollable phenomena that get too noisy or create ambiguous harmony between instruments. So, in my visuals, I just need to pick one small area to limit the scope.That's why I use close-up lens.

IW: That's what I remember being the most surprised by when I saw you perform in Toronto. You usually use a huge projection screen but the size of your canvas for "Alive Visuals" is really tiny in person. I'm also really interested in macro imagery… seeing things in new ways that we don't normally see with our naked eyes. It's like discovering new worlds.

AN: Yeah. [nods head] Discovering new worlds.

IW: How do you think about the relationships between sound and visuals when you perform and improvise? Do certain sounds bring to mind colors or textures for you?

AN: I think you already know about synesthesia. But I don't have that kind of sense [synesthesia]. But, of course, we all have a kind of music and color sense [crossmodal correspondences], like, Mhmm…*Rhapsody in Blue*, has a feeling of blue color, even if it is just the music.[221] So, we might have the same feeling about a melody with a minor chord. It might create a sad feeling. And the major chord, that feels like lights getting warmer or something like that.

AN: So, we have that kind of same feeling, of course. That's why I think if a musician makes a sound on the stage, The color already exists on the stage [through sound] without any visual effect. So as a visualist what should I do when working with a musician? So, plan A is called a "color boost." Like, if a blue tone is played on the stage and I also used the color blue, then the feeling of the blue color is increased for the audience. Or alternatively, if a long tone with a sad blue feeling sounds and I chose red color in the visuals. It creates a strong conflict and a strong feeling for the audience. So, I can choose between having a conversation —a friend's conversation. "Oh, you're sad?" [gestures as if patting an imaginary friend on the back] Using blue in visuals to match the music, is like this, like empathy. But red visuals with blue sounds, it's like saying "My idea is different from your idea. So let's talk a lot!" ... or something like that.

IW: Did you ever play a musical instrument?

[221] Here Nakayama is referencing George Gershwin's composition *Rhapsody in Blue* (1924).

AN: I'm just a big fan of the music. But, when I was in high school, I started as a beginner on bass, electric bass and had a band with my friends, but it was too difficult to tune my pegs [laughs].

IW: I was thinking about the audience from your vantage point as a performer. How does the audience affect your improvisation or how you feel when you're performing on stage?

AN: That question reminds me of an experience I had in a museum in Korea. When I went to the Korean traditional art museum, there was a famous painting. It is India ink on the Korean traditional paper. And the painting is super famous even in Japan.

AN: So [beforehand] I had only seen the photo in an art book, but I wasn't interested in that particular painting because the printed image just picked up the shape of the ink. We can only see the black shape of the ink, but the real painting is totally different. The paper structure and consistency is super natural, organic and beautiful. It's much better than just the black ink part of the painting. So, I realized the shape of the ink was decided by the blank area. Basically, the paper decided the shape of the ink. This was something I didn't, pick up on just from print. So, this experience, becomes an analogy for my relationship as an artist, with the audience. The artist only makes a brush stroke and drops ink on the stage. But the support material is the audience.

AN: So, if the audience is like a soft, traditional paper, the ink is absorbed a lot, and it makes a sensitive pattern inside their heart, I think. The feedback from the audience is so colorful, and I like to hear that after my painting. Mhmm….So, It's not only me, the audience and I made one painting together, I think.

IW: Typically, when you perform, you often have a huge projection screen which can also include or extend to the floor. When you came to Canada, you did a performance in a church in Waterloo, Ontario. I remember that a beautiful rose window in the building became part of your projection surface. Does the performance space have an impact on your performance?

AN: I remember I performed in Sofia, Bulgaria, in a cinema that was placed in front of a public hot spring. As people walked by the cinema they would bring water from the hot spring to their homes. I also used that hot spring water for my ["Alive Painting"], and the characteristic of the water was very unique. In Sofia, that particular kind of hot spring water is also a symbol of the city. So, there is a philosophical side and also the material side, both have a meaning and influence on my painting. So, the performance space is a big part of my painting, I think.

AN: My first performance in a church was in Detroit in the U.S. I thought "I'm not religious"—I don't have a specific religion in Japan— I only have a feeling about that kind of culture or religion, but I'm not Christian. So I [spoke to] the

church person. “I am not Christian, but tonight, I will perform here.” I was afraid to ask, “how do you feel [about] that?” But I asked him, and he said, “here in Detroit, there is a history of many African American activists who took asylum here. Even if they're not Christian, this place is still wide open to the people. This architecture is open for everyone.” So, this church, it was also open, wide open for Christians of course, and also non-Christian persons and for everyone in Detroit. And it [was] also open for the light art festival.

AN: So, I can feel several different types of moods from the information I learned about the venue, just being in the space itself and the audience as well. Of course I can’t know everything about a particular space. Its history, information, and the audience's personality, but I can feel some feelings of the audience. For example, if today is heavy rain or something. I can say: “How are you? Today is a happy evening.” Through my drawings. That's something I try to translate into my drawing strokes.

IW: I notice that you reuse projection surfaces from performance to performance—building up layers —using materials from previous work as a starting point for new improvisations. Could you speak a bit about the role texture and layering plays in your work?

AN: I use almost twenty to thirty support materials [gestures to various plates and petri dishes]…For example, this is a glass petri dish [holds up a glass petri dish and a plastic petri dish] And this is also transparent, but it is plastic. The characteristic of these materials, the transparencies are the same, but the plastic is a weak material. That's why my paint sticks to it well, to the invisible scratches in the plastic, but glass is a super strong material. So, if I want to keep the transparent layers, I choose this [gestures to the glass petri dish] And, also, other metal things [holds up different metal sheets and paper] and this kind [pulls up the petri dish with textures] I think more of as like the landscape materials.

AN: [still holding up a plastic petri dish with layers of dried paint] This landscape material dish already has, maybe 10 layers of dried inks and pigments. So, when I use a halogen light on this, [part of Nakayama’s typical stage setup] the air inside the dried pigment expands and evaporates from underneath of the pigment. In combination with other inks, it creates a unique effect for the stage.

IW: I keep asking you about music because I feel like you have such an organic sense of rhythm and pacing when you paint. Are there any ideas or principles you use to decide how you're going to move from one color or liquid to another? Sometimes it looks to me like you allow things to flow and interact naturally and then you direct it. But then sometimes you set up a reaction or particular set of materials and then let it interact completely at its own pace.

AN: I think it is it is important question for me. For example, if I wait, for my friend in front of the high school, my friend and I can definitely meet at the

entrance. But if it's the weekend, and I walk to the park. And, coincidentally, my friend also happens to walk around the same park. Our meeting is a special coincidence. It is a much more dramatic moment. It's much better than if I wait for my friend in front of the high school. So, I like those kinds of moments of coincidence on the stage. I don't want to wait for something or follow the music and rhythms too exactly. It is predictable.

AN: I have my own lifestyle and rhythm during improvisation sessions, even on the stage as a visual artist. And naturally, the timing comes: the special encounter, like a dramatic moment in our life. I naturally wait for that kind of miraculous moment during the live performance…I will not wait for something to happen and also, I will not follow the sound exactly. I just leave each to its own rhythm.

AN: Of course, professional musicians consciously use overtones in their technique. When natural overtones happen in the live performance. It is a miraculous moment, I think. So, I want to create that kind of special overtone music between the visuals I perform and create living harmony between musicians and visuals on the stage. It's like a natural conversation with friends like that, but much more special with overtones. If I want to get that, I need to keep my own rhythms.

IW: In your artist statement you say that your work is concerned with the philosophical meanings of color, shapes, and movement. I just wondered if you could talk about that a little bit. I think you have already touched on this, but if there's anything else you wanted to add.

AN: Yes, Especially the use of the bubble shape inside my painting. Yeah.

AN: In each country, I think there are some philosophical meanings for the bubble shape, I think. Sometimes it is a metaphor for the ephemeral or for fragility. In Japan, it is the same. So, during performance, if I meet the single bubble while painting. Naturally, it brings up the metaphor of the human or some fragility.

AN: But in physics, the round shape is a strong shape, I think, because of the surface tension balance, it is perfect and makes a round shape perfectly. So that kind of theory and the order of the physics of shapes, tells me it [the bubble] has a strong shape and strong characteristics. But, for the philosophical side, it is a metaphor of fragility. But I like that kind of conflict of meanings. So, I often bring that kind of conflict and paradox inside my painting.

Chapter 3 TWILIGHT EXPERIENCES

Introduction

In this chapter, I will further examine how crossmodality has manifested within my creative practice by discussing recent examples—*Epistolary Transmissions*, *Ember*, *Live Audiovisual Practice/Performance*, *Archive*— that fall broadly into three categories: graphic scores with modular components; experiments in collaborative live audiovisual improvisation; hybrid work which blends aspects of both. Motivated by a desire to eschew the rigid composer/performer binary of Western classical music, my collaborative creative work has evolved to center graphic notation geared towards encouraging performers to improvise with and reconfigure materials in an individualistic and inherently crossmodal way.[222] In particular, I'm interested in creating scores that provide opportunities to explore the wide variety of ways that individuals respond to and from crossmodal auditory associations with various visual stimuli.

As a classically trained violinist, my formative training celebrated the "musical work-concept", or masterwork. Lydia Goehr discusses the evolution of the work concept, which she argues originates in the early nineteenth century, a period when "works were not to be thought about as expressive or representative of concrete historical moments, but as valuable in their own right as transcending all considerations other than those of an aesthetic and spiritual nature."[223] In order to elevate music from the past and "into the sphere of timelessness," it became necessary to decouple it from its sociohistorical context: "The canonization of dead composers

[222] Blum explains: "In several areas of Western musical life over the past two centuries, two activities have often been specified as what musicians generally do: composition of a work intended for performance at a later date, and performance of a composition learned in advance—often called simply composition and performance.[...] It encapsulates a narrative that can be briefly summarized as follows: composers produce original works, which they notate so performers will present them in a convincing manner…" Stephen Blum, "Representations of Music Making," in *Musical Improvisation: Art, Education, and Society*, ed. Gabriel Solis and Bruno Nettl (University of Illinois Press, 2009), 239–40.

[223] Goehr, *The Imaginary Museum of Musical Works*, 246.

and the formation of a musical repertoire of transcendent masterpieces was the result both sought and achieved."[224] An imperialist ideology emerged in Europe which valued Classical music as the standard against which all other musics were measured. As Goehr reminds us: "Gradually, for a variety of complex reasons, music of the classical period came to be viewed as the most perfect and valuable sort that had ever been produced."[225] It is beyond the scope of my discussion here to examine the far reaching repercussions of this hegemonic ideology, but I can connect it vividly to my own experiences as a classical performer, particularly with respect to striving to realize an impossible standard of perfection, which Goehr argues is a defining characteristic. Along with strict delineation of musical roles Goehr points out that "Perfect compliance is an ideal we strive towards in the performance practice of classical music. It is an ideal of paramount evaluative and aesthetic importance that performers strive to produce perfect expressions of works."[226] A further personal consequence, was the internalization of a tacet understanding that as a performer, my purpose was to interpret not to create.[227] Sadly, it has taken me longer than I care to admit to feel comfortable stepping outside of my perceived role as "interpreter" to be able to make original works for myself and others.[228] Christopher Small reminds us that the historical delineation of performer as subservient to the score and by

[224] Goehr, 246–47.

[225] Goehr, 247.

[226] Goehr, 99.

[227] By this statement, I do not mean to devalue the creativity, tremendous skill and painstaking effort that goes into realizing works from the traditional classical canon, only that I personally found the expectations associated with interpreting "masterworks" to be at best stifling and at worst responsible for an unhealthy desire to strive for perfection that could be both physically and psychologically harmful.

[228] In fact, my first tentative experiments happened in October 2018 and were the result of an assignment by Prof. Mark Dresser to create a graphic score for the purpose of developing a group improvisation (University of California, San Diego, Mus 201, Improvisation Ensemble).

association, the creative "genius" of the composer, is in fact "a comparatively recent phenomenon. At least until the end of the eighteenth century the ability to extemporize was an essential element of the skills of any musician worthy of the name. We should remember that those whom we call the 'great composers' of the past, at least up to the time of Beethoven, saw themselves not just as composers but as working musicians whose duties centered around performance."[229] For the past few years, my response to the hierarchical distinctions between musical roles inherent in the musical work-concept has been to embrace the idea of a score as "an invitation to collaborate" rather than a blueprint requiring strict adherence to notational rules and stylistic conventions.[230] As Alex Waterman says: "When notation no longer acts as a directive, but instead as a question or proposal for a new language, for collective reading of a piece of music, direct contact is located between the composers, and often supplants the need for direct contact with the composer."[231] Through open-ended text instructions, abstract graphic notation and modular components, I aspire to welcome fellow collaborators to share in the authorship and realization of a creative work.

Epistolary Transmissions (2021), *Ember* (2021), and *Archive* (ongoing) draw inspiration from aspects of three graphic scores with modular components composed in the mid twentieth century—a period when many artists were similarly looking for ways to subvert established

[229] Christopher Small, *Music of the Common Tongue:Survival and Celebration in African American Music* (Hanover, NH: Wesleyan University, 1998), 299.

[230] Christopher Williams, "Tactile Paths: On and through Notation for Improvisers" (Phd diss, University of Leiden, 2016), 91. "an invitation to collaborate" is a quote from Richard Barret sent in a personal email to the Christopher Williams, December 12, 2015 — I was first introduced to this concept during a graduate Experimental Studies Seminar on improvisation and notation taught by Prof. Wilfrido Terrazas at the University of California San Diego (Mus 206, Spring 2021).

[231] Alex Waterman, "Between Thought and Sound: An Essay in Three Parts" in, Alex Waterman, Debra Singer, and Matthew Lyons, eds., *Between Thought and Sound: Graphic Notation in Contemporary Music* (New York, NY: The Kitchen, 2007), 67.

hierarchies between notation, performance and improvisation: John Cage's *Fontana Mix* (1958) and George Brecht's *Water Yam* (c. 1963) and Cornelius Cardew's *Treatise* (1967). For the purposes of this dissertation, I consider graphic scores with modular components to include compositions where pages or notation elements can be isolated and rearranged in various ways. My interest in these works lies in their inherent crossmodality, configurability and indeterminate nature.

Fontana Mix is a graphic score composed of ten sheets of paper with organically curving solid or dotted lines of various thicknesses, ten transparent sheets with irregularly scattered points, and two further transparent pages (a grid twenty units by one-hundred units and a single straight line).[232] It was originally intended to serve as a means for Cage to use indeterminate compositional techniques to create a piece for magnetic tape. While the component parts of the score appear abstract—lines, curved shapes, points— Cage's instructions for how to configure and interpret the relationship between the various graphic elements are highly specific and require precise calculation to determine various audio characteristics and sound classifications.[233] Ultimately, Cage realized that by making the instructions more general—in terms of time frame and source materials— the score could function as a tool to generate further performance scores.[234] Cage would go on to use *Fontana Mix* as a variable blueprint to generate several of his

[232] In 1958, Cage had been invited to Italy by composer Luciano Berio to create a piece for magnetic tape at the famed Studio di Fonologia Musicale in Milan. Originally titled *Performance Mix*, Cage ultimately changed the name to honor his Milanese landlady, Signora Fontana.

[233] Dustin Donahue, "Variations: Four Studies in the Aesthetics, History, and Performance of Indeterminate Music" (UC San Diego, 2016), 50, https://escholarship.org/uc/item/03m2f2kn. In order to realize two original seventeen-minute versions for magnetic tape, Cage undertook several hundred separate readings of the score.

[234] Cage subsequently updated the instructions in the score to specify that "the use of this material is not limited to tape music, but may be used freely for instrumental, vocal, and theatrical purposes." John Cage, *Fontana Mix*. New York: Henmar Press/C.F. Peters, 1960.

most well-known works from the period (1958-1960): *Water Walk* (1959), *Sounds of Venice* (1959), *Aria for M. Sop.* (1958), *Theatre Piece* (1960), and *WBAI* (1960).[235] Fontana Mix is the first score with modular components that I encountered during my undergraduate degree. While I didn't have the chance to engage with it directly—either as a tool to create new work, or through performing any of the existing permutations listed above— I remember being fascinated by the materiality and configurability of the scores themselves as well as the potential for the interpreter to have an objectively significant and idiosyncratic impact on the final outcome.

First published in 1963, Water Yam is a collection of event scores by Fluxus member George Brecht (1926-2008).[236] Despite subtle variation in its constituent parts from edition to edition, Water Yam consists of between 70-90 loose scores simply typeset on white cards of varying dimensions and enclosed in a box.[237] Event scores were a type of text score first pioneered by Brecht between 1959 and 1962 and subsequently embraced by other Fluxus artists (e.g. Yoko Ono, Ken Friedman, Alison Knowles). Knowles describes event scores as involving, "simple actions, ideas, and objects from everyday life recontexualized as performance. Event Scores are texts that can be seen as proposal pieces or instructions for actions. The idea of the score suggests musicality. Like a musical score, Event Scores can be realized by artists other than the original creator and are open to variation and interpretation."[238] Brecht attended Cage's

[235] James Pritchett, *The Music of John Cage. Cambridge* (Cambridge, England: Cambridge University Press, 1993), 132.

[236] Fluxus member and impresario George Maciunas was responsible for designing the box and typesetting the score cards.

[237] Natilee Harren, "The Diagram Dematerialized, from Marcel Duchamp to John Cage to George Brecht," *Athanor* 26 (2008): 99.

[238] Alison Knowles, "Event Scores," aknowles.com, accessed July 27, 2024, https://www.aknowles.com/eventscore.html#.

seminar on experimental composition at the New School for Social Research between June 1958 and August 1959 (around the time that Cage was rethinking the use of chance as a compositional tool and embracing indeterminacy and graphic notation in his own scores—see *Fontana Mix* and its permutations).[239] Encouraged by Cage to expand his preliminary experiments, Brecht developed a model for the event score during the seminar which he would go on to hone over the next few years. Robinson notes: "By 1962, [Brecht] had expanded the parameters of the Event, refined the form, and written over one hundred short textual scores"[240]—many of which would go on to be included in various editions of Water Yam. Encountering Brecht's Event Scores further shifted my understanding of the range of possible relationships between composer, performer and audience, and the potential inherent in text scores to integrate the everyday in surprising new ways into scores using the written word.

Cornelius Cardew's (1936-1981) *Treatise* is a monumental and enigmatic 193-page graphic score first published in 1967. Completed over the course of five years (1963-1967), *Treatise* was influenced by the philosophy of Ludwig Josef Johann Wittgenstein, in particular *Tractatus Logico Philosophkus* which inspired the title *Treatise.* It was also inspired by Cardew's desire to expand on innovations in notation introduced by composers from the New York School— notably Cage, Earl Brown (1926-2002), Morton Feldman (1926-1987) and Christian Wolff (b. 1934)—whose indeterminate approach influenced him to rethink the role of traditional notation in Western classical music.[241] Following the completion of a one-year typography

[239] Pritchett, *The Music of John Cage. Cambridge*, 109.

[240] Julia Robinson, "From Abstraction to Model: George Brecht's Events and the Conceptual Turn in Art of the 1960s," *October* 127 (2009): 77.

[241] David Cline, "Treatise and the Tractatus," *Journal of the Royal Musical Association* 145, no. 1 (May 2020): 121, https://doi.org/10.1017/rma.2020.5.

course at the London College of Printing, Cardew worked periodically as a graphic designer at Aldus Books in London.[242] Describing the impact of his design work on the creation of Treatise, Cardew recalled: "The idea of writing Treatise came to me at a time when I was working as a graphic designer in a publisher's office. While there I came to be occupied more and more with designing diagrams and charts and in the course of this work I became aware of the potential eloquence of simple black lines in a diagram."[243] Treatise consists of sixty-seven different graphic symbols which fall broadly into three categories: numbers, elements of musical notation(footnote) and abstract shapes.[244] In addition to symbols, most pages of the score contain two constant elements: a "lifeline" in the form of a horizontal line dividing the page in half, and two staves running along the bottom. Cardew published the work without the intention of including instructions or performance notes: "I wrote Treatise with the definite intention that it should stand on its own without any form of introduction or instruction to mislead prospective performers into the slavish practice of 'doing what they are told'."[245] Here, Cardew alludes to his desire to use graphic notation as a means of providing performers with creative freedom to engage with the work on their own terms. Despite the apparent openness of interpretation afforded to performers in the absence of instructions, the score itself presents intriguing contradictions between freedom of expression and implied musical structure through shape-

[242] Interestingly, between the years of 1956-1958 Cage also worked as a commercial artist for the textile company Jack Lenor Larson, Inc.

[243] Cornelius Cardew, *Treatise Handbook: Including Bun No. 2 [and] Volo Solo , Cornelius Cardew.*, Edition Peters ; Nr. 07129 (London ; Edition Peters, 1971), x.; Cline, "Treatise and the Tractatus," 123.

[244] Brian Dennis, "Cardew's 'Treatise' (Mainly the Visual Aspects)," *Tempo*, no. 177 (June 1991): 10, https://doi.org/10.1017/S0040298200013516. Cardew used conventional musical symbols in an enigmatic way, typically untethered from many of the relational specifics on which interpreting their meaning traditionally relies.

[245] Cardew, *Treatise Handbook*, ii.

sound correspondences. The design of the original publication provides some potential clues as to Cardew's intentions. Cline notes:"...Treatise is presented in a spiral-bound book, consisting of numbered pages in number sequence. Equally noteworthy is the fact that the printing is double-sided. This is important, not only because it deters disassembly, but also because it results in pages being displayed side by side in pairs. This mode of presentation subverts perception of individual sheets as framed pictures."[246] By publishing as a single bound volume, rather than loose folio, Cardew seems to imply that performers should use a conventional linear orientation when reading the graphic elements on the page (i.e. left to right).[247] In the *Treatise Handbook*, somewhat reluctantly published in 1971, Cardew provides the following anecdote, dated March 1963:

> Interpreter! Remember that ·no meaning is as yet attached to the symbols. They are however to be interpreted in the context of their role in the whole. Distinguish symbols that enclose space (circle, etc.); those that have a characteristic feature. What symbols are for sounding and what for orientation. Example: The horizontal central bar is the main and most constant orientation; what happens where it ceases (or bends)? Do you go out of tune (e.g.)?[248]

Cardew seems to be suggesting that he intended performers to rely on various types of shape-sound correspondences—familiar to interpreters of traditional musical notation—as a means of determining a way to traverse the score. The Treatise Handbook also provides a fascinating glimpse into Cardew's half decade long relationship to the work, reflecting his evolving attitude

[246] Cline, "Treatise and the Tractatus," 138.

[247] This is further amplified by imagery which traverses multiple pages, the continued presence of the lifeline (albeit with a few variations) and the conventional orientation of musical symbols and numbers in relation to both.

[248] Despite his original wishes, Cardew was ultimately persuaded to compile *Treatise Handbook* for publication in 1971. The *Handbook* includes anecdotes, essays and notes as well as scores for *Bun no. 2* and *Volo solo*. In his introduction, Cardew makes it clear that he was coerced into creating a compendium to accompany the score. Cline notes: "What had persuaded him, he said, was the prospect of including the score of Volo solo, an offshoot of the Treatise project, which he had struggled to place with a publisher. Cline, "Treatise and the Tractatus," 125.; Cardew, *Treatise Handbook*, 3.

towards notation and improvisation—which shifted dramatically over the period of its composition—and was greatly impacted by becoming a member of the AMM in 1966.[249] In Feb, of the same year, Cardew would write the following:

> "Joining the AMM was a turning point, both in the composition of Treatise and in everything I thought about music up to now. Before that, Treatise had been an elaborate attempt at graphic notation of music; after that time it became simply graphic music (which I can only define as a graphic score that produces in the reader, without any sound, something analogous to the experience of music), a network of nameless lines and spaces pursuing their own geometry untethered to themes and modulations, 12-note series and their transformations, the rules or laws of musical composition and all the other figments of musicological imagination."[250]

My fascination with Cardew's *Treatise* is rooted in the inventiveness, precision, elegance, and humor of the notation itself. The sheer volume and scope of the work means that engaging with even a single page, feels comparable to using a microscope to explore uncharted worlds—in this case, the potential for an infinite variety of musical interpretations via crossmodal connections.

In my own practice, the influence of *Fontana Mix, Water Yam,* and *Treatise* manifests in two characteristics: the use of tactile modular components such in score cards or configurable elements that performers can engage with—either physically or digitally; using text instructions paired with graphic imagery (devoid of references to traditional musical notation) which encourages performers to approach the score as "an invitation" to use whatever musical idioms,

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[249] The AMM is a London based ensemble dedicated to experimental music and free improvisation. Keith Rowe, Lou Gare, Eddie Prevost and Laurence Sheaff were key members at the time Cardew joined in 1966. He would be a member until the late 70's when Cardew would renounce experimental music, including *Treatise* and his own earlier works.

[250] Cardew, xi. Contrastingly, in a note dated Dec 1963, Cardew wrote: "To a person who thinks the piece is a code to which the key is missing, what I am doing will look like providing a key. Actually I am simply interpreting. The piece is an abstract work of design, to which meanings have to be attached such that the design holds good". This particular anecdote from early in the composition process, goes on to detail exhaustive instructions for how to approach interpreting various shapes in the score in a highly systematic manner —e.g. assigning specific auditory parameters to various components of a triangle for example.; Cardew, vi.

instruments (or objects) that they feel inspired to employ. The underlying intention in both cases being to foster the potential for an infinite variety of interpretations, through a network of personal crossmodal correspondences.

3.1 Epistolary Transmissions

My initial foray into modular graphic scores was a partially realized project called *Epistolary Transmissions* (2021) which was developed during the depths of the COVID19 pandemic. Drawing inspiration from the work of mail artists such as Ray Johnson (1927-1995), The New York School of Correspondence Art and Fluxus, the intention behind *Epistolary Transmissions* was to "weave together a multi-layered and ultimately interactive sonic experience which foster[ed] hybrid modes of distanced communication/tranception through merging digital and physical processes"[251] Participants could choose to receive one of two types of scores in the mail: "solitaire"— a set of cards featuring QR codes corresponding to audio files/links (See Figure 3.1 and 3.2); "postcard"— a one-of-a-kind graphic score card with accompanying personalized message (See Figure 3.3).[252] Each set of "solitaire" cards was linked to six unique sound files. [253] Accompanying instructions invited participants to draw inspiration

[251] Ilana Waniuk, "Epistolary Transmissions", unpublished instructions, 2021, 1.; Originated in the 1950's, "mail art" grew out of movements like Dada, Futurism and Surrealism that "dabbled with social connectivity." In the mid 1950's artist Ray Johnson began experimenting with creating artworks and mailing them to friends: "Fascinated by collage and communication, Johnson began to compile artists, art historians, art connoisseurs, other members of the downtown New York arts scene and even celebrity figures whom Johnson could locate in the phone book. He used the list as participants in a postal network or letter chain." Johnson used collage techniques in his work, incorporated imagery cut from magazines, photographs, advertisements and consumer goods packaging along with drawings and paintings. The term "Mail Art" was first used by artist Edward Plunkett (1939-2011) to refer to the movement that by the 1960's had expanded into several distinct branches "the New York Correspondence School", Nouveau Realists in Europe and various artists in Japan (e.g. members of the Gutai Art Association) and the U.S. who were associated with the Fluxus movement. Another characteristic of mail art is the idea of "collective authorship across a geographically diverse setting, whereby a receiver of a work would 'add to' and mail the piece to the next artist." Mail art has since expanded to encompass new forms of digital communication. Seeta Peña Gangadharan, "Mail Art: Networking without Technology," *New Media & Society* 11, no. 1–2 (February 2009): 285, https://doi.org/10.1177/1461444808099581; Gangadharan, 280–81.; Ken Friedman, "The Early Days of Mail Art," n.d.

[252] Participants received their scores in the mail accompanied by a personal message and a page of instructions for how to approach the score.

[253] Sound files ranged from field recordings and YouTube clips of various ephemera (e.g. foley sounds, crowds, ASMR cooking videos) to improvisations and sound collages uploaded to SoundCloud as unlisted links. The following sample link is a field recording I took on a walk in February of 2021 https://on.soundcloud.com/Uved9hBrD4ir3dLr8

from, reconfigure, or add to one or any number of the existing recordings by layering them in a DAW. The final step being to share their personal interpretations as audio files which would have been added to a hypothetical online platform for the public to view and interact with. Scores were created by collaging together various ephemera including photocopies of postcards, old family photos, and letters that I gathered from my parents' home— where I was staying during lockdown.[254] Instructions for "solitaire" and "postcards" were some of my first experiments in guiding participants to interact with sonic materials and freely interpret graphic visuals rather than a precise set of instructions yielding predictable sonic results.

Figure 3.1: Set of "solitaire" cards (front view) from *Epistolary Transmissions*

Figure 3.2: Partial set of "solitaire" cards (back view) from *Epistolary Transmissions*

[254] I used postcards gathered by my mother and her family dating back to the 50s, many of them black and white photos of museum artifacts and paintings collected while on vacation. As a child I had been fascinated by the well-worn edges, yellowed paper, and foreign postage. Rifling through the collection felt like a clandestine glimpse into another time; a faded but tangible link to histories and family members I had never met and places I had never been.

Figure 3.3: Four examples of "postcards" from *Epistolary Transmissions*

My approach to creating the graphic notation for "postcards" was intuitive, in the sense that I did not plan out the design for each score prior to sitting down to create it. Rather, through a process I would consider to be improvisational, I began with a blank postcard template, and chose from a set of materials (e.g. assorted papers, magazines, colored pencils, oil pastels, India ink etc.) to arrange into a collage or visual "composition."[255] I was cognizant that variations in visual characteristics such as hue, saturation and brightness— when paired with amodal features like shape, size, texture and spatial location relative to the orientation of the score and other graphic elements—could be interpreted by performers to correspond to distinct sonic events.[256]

[255] The template I created was modeled on vintage postcards from the aforementioned family collection.

[256] In this case, both physical and visual texture.

As such, the physical materials I manipulated felt vividly analogous to musical content and I attempted to arrange the graphic elements according to how I imagined they might be interpreted by improvisers on a theoretical timeline. In addition to considering the potential for performers to structure their improvisation through forming individualistic mappings between specific visual components and musical principles of organization— rhythm, timbre, pitch, tonality etc.— I also considered what emotions or moods might be associated with each score, bearing in mind that by working in the tradition of collage, I was incorporating elements that were not always abstract and as such had the potential to evoke specific denotative or connotative meaning for performers.[257] Though each "postcard" could be interpreted as a linear sequence of discrete or overlapping sonic events, I wasn't strictly interested in dictating how to interpret the graphic notation. I did, however, include some suggestions for possible approaches in the instructions, but I was more curious to discover how performers would create their own unique crossmodal correspondences as they attempted to translate the visual into the auditory.

Epistolary Transmissions involved sending scores to twenty different artists from across Canada, the U.S, Mexico, Iceland and Australia. While I only received responses from a handful of participants, the breadth and variety of interpretations ultimately inspired me to continue to

[257] My choice to use the medium of collage to create scores for *postcard* was an additional nod to the tradition of mail art—artists like Ray Johnson frequently used collage techniques within their work. Originating in the Cubist movement, and subsequently embraced by Surrealist and Dadaists of the early 20th century, collage emerged in response "to the fragmented nature of modern life and the desire for new artistic languages." Collage techniques were also used by artists in various movements such as Mail art, Pop Art, and Fluxus. Characterized by techniques such as cut and paste, assemblage (the incorporation of various three-dimensional materials), photomontage (creating collage primarily through manipulating existing photographs) and digital collage, collage has become a "tool for critiquing societal norms, delving into the realms of the subconscious, and reflecting the consumerist culture of the time." Victor Onibere, "Evolution of Collage as a Medium and Its Influence on Modern Art," 2024, 5.; Craig notes that "by way of its multiplicitous nature, collage is often perceived to both signify the spirit of contemporary culture (particularly in relation to its continual hybridization), and a desire to preserve cultural signs and nostalgically nod at a 'better', less chaotic past." In the case of *postcards*, I used the medium of collage more as a gesture of connection and vulnerability. Sharing glimpses of my personal and ancestral history felt especially meaningful during a period of physical isolation and lock down. Blanche Craig, *Collage: Assembling Contemporary Art*, ed. Blanche Craig (London: Black Dog Publishing, introduction, 2008).

explore modes of graphic notation which foreground freedom of interpretation and creative agency for performers.[258]

3.2 Ember

Building on the mutable nature of *Epistolary Transmissions*, *Ember* (2021) is a modular graphic score for any number of improvising musicians/performers. Originally created for oboist Juliana Gaona and vocalist Natalia Merlano Gómez, *Ember* consists of three video scores and seven photo scores. Performers can engage with as many or as few modules/scores as they wish in any combination and are free (though not required) to manipulate the scores as source material to craft their own distinct fixed visual media to be projected at a given performance. *Ember* was premiered as part of *Resonancias Entrelazadas*, a virtual concert and recording project devised by Gómez and sponsored by the Colombian Cultural Ministry. *Resonancias Entrelazadas* featured fifteen works by female identifying composers from around Bolivia, Canada, Colombia, New Zealand/U.S.A., Slovakia, and the Ukraine performed by Colombian women performers.[259]

Visuals for the scores were devised in response to recordings of a series of distanced improvisations for voice, electronics, oboe and English horn that Gómez and Gaona completed over a period of several weeks in the winter of 2021. At the time, Gómez had recently purchased an effects pedal and was experimenting with ways to incorporate live electronics into her

[258] See Audio Files 3A. Epistolary Transmissions_Postcard Response_Dobrochna Zubek and 3B. Epistolary Transmissions_Solitaire Response_ resonantModes_Andrés Gutiérrez Martínez for two examples of submissions I received in response to the score. 3A was contributed by Polish/Canadian cellist Dobrochna Zubek, and 3B by UCSD PhD Alum Mexican composer Andrés Gutiérrez Martínez.

[259] See the link below to hear a recording of *Ember* created by Juliana Gaona Villamizar (oboe/English horn) and Natalia Merlano Gómez (voice and electronics): https://nataliamerlanogomez.bandcamp.com/track/ember-composer-ilana-waniuk-performed-with-juliana-gaona

improvisatory practice.[260] Using the pedal's looping capabilities, and atmospheric effects such as reverb, delay and chorus, her improvisations were geared towards uncovering new methods of integrating standard and extended vocal techniques with electronics. Both Gómez and Gaona used breath/air sounds, noise (e.g. distortion via effects pedal, oboe/English horn multiphonics) and unpitched, percussive techniques such as tongue clicks and key clicks to create complex layers of sonic texture and provide contrast to other pitched materials. Gaona contributed energy and dynamism to the improvisatory dialogue through atonal and modal melodic figuration that traversed rapidly from one extreme of range to another, low resonant pedal tones, and haunting mid-range melodies capable of weaving in and out of unison with Gómez's voice.[261] Her improvisatory arsenal also included the production of an astonishing array of multiphonics on both English horn and oboe. As the name implies, multiphonic literally means "many sounds." For woodwind instruments with conical bores —oboe, English horn, saxophone and bassoon— multiphonics are used to describe an acoustic phenomenon whereby "certain unorthodox fingerings and/or embouchure adjustments can result in...two [or more] separate pitches sounding simultaneously."[262] In contrast to cylindrical bore instruments such as the flute and clarinet, the system of acoustic vibrations within a conically shaped instrument is "complex and irregular."[263] Backus explains that multiphonics "are produced by the simultaneous vibration

[260] TC-Elicon VoiceLive Touch 2 Effects Pedal

[261] Ertuğrul Sevsay, *The Cambridge Guide to Orchestration* (New York, UNITED STATES: Cambridge University Press, 2013), 78–79, http://ebookcentral.proquest.com/lib/ucsd/detail.action?docID=1182955. Gaona's range spans from E2-C6 on the English horn and Bb3-A6 for the oboe.

[262] John Backus, "Multiphonic Tones in the Woodwind Instruments," *The Journal of the Acoustical Society of America* 63, no. 2 (February 1, 1978): 591, https://doi.org/10.1121/1.381758.

[263] Libby Van Cleve, *Oboe Unbound: Contemporary Techniques*, Revised edition., Oboe Unbound (Blue Ridge Summit: Rowman & Littlefield Publishers, Incorporated, 2014), 30.

of the air column at two frequencies that are not harmonically related,"[264] causing "[m]any if not all, of the pitches… to deviate from standard tuning."[265] Multiphonics result in complex spectral effects that are notoriously challenging to control and which have intrigued countless composers working in the tradition of experimental and contemporary western classical music in the 20th and 21st centuries. Van Cleve notes that the timbre of multiphonics can range from "raucous conglomerates with lots of beating to delicate wisps; some are highly complex, and some are much simpler."[266] Gaona's skilled and inventive use of multiphonics added a layer of fascinating timbral interactions between voice, English horn/oboe and electronics. While distance, cost and pandemic safety concerns prevented me from witnessing the improvisations in real time, digital recording technologies presented an opportunity for repeat listening which I might not otherwise have had. I was able to familiarize myself more intimately with the musical relationships that Gómez and Gaona were cultivating which ultimately provided a wealth of crossmodal inspiration for the graphic lexicon I would go on to develop.

I was eager to explore audiovisual crossmodal correspondences between the timbral complexity inherent in Gómez and Gaona's improvisations and imagery that was "fuzzy" or "blurred" (i.e. contained less easily distinguishable visual elements than the scores for *Epistolary Transmissions*). Blur —both motion blur and soft focus— is deeply embedded in the history of photography and has been used to connote a variety of meanings. In the late nineteenth and early twentieth centuries soft focus was used by the pictorialists to emulate painterly techniques,

[264] Backus, "Multiphonic Tones in the Woodwind Instruments," 599.

[265] Van Cleve, 30.

[266] Van Cleve, 30.

oftentimes through elaborately staged scenes,[267] so as to "reveal the indefinite and the intangible."[268] A convention in opposition to concurrent photographic trends that valorized clarity, objectivity and scientific inquiry. Blur has represented imperfection, technical error and amateurishness, while simultaneously signifying authenticity in the realm of street photography and photojournalism.[269] Another facet to consider is the trend towards fetishizing imperfection in contemporary photography (see Lomography).[270] Berndt Steigler suggests that in our current era of digital photography, photoshop and camera phones, imperfections and artifacts such as blurriness have become a sought-after aesthetic:

> photography has become enamored of and committed to inaccuracy, because it enables a form of representation that aims to conceptualize reality in a unique aesthetic manner. This is a strange vestige of the photographic, which, far removed from the epistemic contexts of the 19th and early 20th century, conveys an aesthetization of the ordinary. Imperfection transforms every object into a photographic reality, which emphasizes a different regime of images precisely by eschewing and renouncing the perfection of technology.[271]

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[267] Ann Lee Morgan defines pictorialism as: "An international art photography movement cresting in the first decade of the twentieth century. Pictorialism aimed for artistic effects that imitate and rival those of traditional pictorial arts, particularly painting and graphic media. More specifically, the term in this period came to be particularly associated with gentle idealism, spiritual longing, and wistful retreat from the modernizing forces transforming Western societies."Ann Lee Morgan, "Pictorialism," in *The Oxford Dictionary of American Art and Artists* (Oxford University Press, 2018), https://www.oxfordreference.com/display/10.1093/acref/9780191807671.001.0001/acref-9780191807671-e-1051.

[268] Alix Beeston, "Blur," *Modernism/Modernity Print Plus* 7, no. 1 (2022): 2.

[269] Good observes that, "blur has come to be associated with a kind of privileged authenticity in photojournalism, precisely because of the way in which it signals the chaotic, "out-of-control" movement…"Jennifer Good, "The Impossible Photograph: Blur and Domestic Violence," *Photography and Culture* 12, no. 4 (October 2, 2019): 418, https://doi.org/10.1080/17514517.2019.1665326.

[270]The Lomo Kompakt Automat is a compact and affordable camera originating in Russia in the 1990's which spawned a global movement of amateur and professional photographers "dedicated to analogue, experimental, and creative photography." "Lomography," accessed July 22, 2024, https://www.lomography.com/about.; The website Analogue Wonderland describes Lomography as: "a style of photography... characterized by its use of low-fi cameras, unpredictable results, and a focus on capturing the beauty in everyday moments" (n.d)"The History and Evolution of Lomography," Analogue Wonderland, accessed July 22, 2024, https://analoguewonderland.co.uk/pages/lomography.

[271] Bernd Stiegler, "1. Imperfection," Fotomuseum Winterthur, accessed July 20, 2024, https://www.fotomuseum.ch/en/2012/01/11/imperfection/.

Referencing blurriness in vision, but equally relevant to our perception of motion blur as conveying movement and energy in still images, Keith Allen suggests that "blurred experiences provide too much, inconsistent, information about objects' spatial boundaries, by representing them as simultaneously located at multiple locations."[272] Good concurs, "When motion blur occurs in a photograph, it is a demonstration of the fact that no photograph is instantaneous."[273] It reminds us that all still photography is "inhabited by duration," something I was particularly interested in emphasizing within *Ember*.[274] My first conscious exposure to the use of blur as a deliberate photographic technique was through the works of Francesca Woodman and Rinko Kawauchi.[275] Despite having vastly different subject matter and visual styles — I was fascinated by the way that both artists used blur and soft focus to convey mood and otherworldliness, creating photographs that were "'thick' with atmosphere."[276] In a similar vein, I wanted the scores for *Ember* to impart layers of meaning while leaving as much space as possible for

[272] Keith Allen, "Blur," *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 162, no. 2 (2013): 257.

[273] Good, "The Impossible Photograph," 417.

[274] Good, 417.

[275] Francesca Woodman's (1958-1981) haunting black and white photos frequently feature blurred images of the female form against a sharply depicted backdrop of abandoned or derelict building interiors. In her article "Transitory Ghosts and Angels in the Photography of Francesca Woodman", Boucher suggests that Woodman used experimental techniques such as motion blur and double exposure to present, "her own, or her models', naked or partially clothed body refigured as ghost-like or angelic and captured in moments of disappearance, displacement or transformation (Angel Series, 1977-78; House Series, 1976)."Georgie Boucher, "Transitory Ghosts and Angels in the Photography of Francesca Woodman.," *Traffic (Parkville)*, no. 9 (January 1, 2007): 1.; Japanese photographer Rinko Kawauchi (b. 1972) uses blur and soft focus to create ethereal and poetic photographs—both abstract and representational. Often depicting the quiet beauty and ephemerality inherent in everyday life, Simon and Brynce (2022) describe Rinko's work as conveying mundane details in a "dream-like haze...resulting in work that is positioned as exploring a 'subtle, poetic, and spiritual sense of self.'"(p. 647).Jane Simon and Mio Bryce, "The Labour of Light: Gender, Technology and the Domestic in the Photography of Nagashima Yurie and Kawauchi Rinko," *Women's History Review* 31, no. 4 (June 7, 2022): 647, https://doi.org/10.1080/09612025.2021.1944351.

[276] Shawn Michelle. Smith, *At the Edge of Sight: Photography and the Unseen.* (New York, NY, USA: Duke University Press, 2013), 45. For further examples of photographers whose work embraces or incorporates blur in various ways please see the work of Robert Frank, Hiroshi Sugimoto, Uta Barth and Catherine Leutenegger.

performers to draw their own conclusions about the graphic content—thereby ensuring the potential for infinite variety and malleability of musical interpretation. As such, I opted to use a DSLR camera with long exposure times in order to integrate blur as a thematic and visual element within several of the score modules.[277]

When creating *Ember*, I wanted to echo the ephemeral nature of free improvisation by integrating image making strategies that involved indeterminacy. Drawing on techniques used in liquid light shows, collage and experimental photography, video content and still images were generated by physically manipulating materials (e.g. paper, ink, water, hair dryer and colored lights), documenting the impermanent results via digital means (iPad, and DSLR camera), and further refining the imagery through digital editing software such as Premiere Pro and Photoshop. For example, *Ember* scores *II* and *III* (see Figure 3.4 and 3.5), involved taking photographs of unfixed collages. By not securing the visual composition to a flat surface using glue or paint, a digital photograph was the only remaining record of the work. Ephemerality was further emphasized by long exposure photography techniques—moving either the lens or various physical components of the collage with my hands—to produce irreplicable textures and ghostly effects through motion blur.

[277]Canon EOS Rebel T7

Figure 3.4: Score *II* from *Ember*

Figure 3.5: Score *III* from *Ember*

Figure 3.6: Score *VI* from *Ember*

In terms of crossmodal correspondences, the colors, textures and visual compositions I created, loosely reflected and were intended to stimulate the scope and inventiveness of Gómez and Gaona's improvisatory dialogues. I primarily chose dark and muted colors for all three video modules with the idea that the color palette might be interpreted as corresponding to low range, dark timbre, dissonant intervals or modal melodic content. More saturated, or luminous colors by extension, could suggest contrasting moods or musical material (e.g. brighter timbre, higher range, etc.). I imagined that monochromatic images featuring complex textures and organic patterning—see score *VI* (Figure 3.6)— reflected various types of unpitched material, extended techniques (e.g. noise and distortion) or repeated irregular rhythmic motives. Drawing inspiration from Akiko Nakayama's "Alive Painting," the movement of visual elements in video scores was often slow paced, providing the potential for temporal crossmodal correspondences between sustained pitches and simple fluid dynamic principles (e.g. flow and viscosity). Dark colors and fuzzy or blurred textures in video scores *II* and *III* could be mapped to diffuse electronic effects

such as reverb or distortion and helped to set the kinetic motion of delineated shapes in relief, hinting at the possibility of various bi-layered or two-part musical structures. These examples are just some of the relatively simplistic crossmodal correspondences I had in mind while creating score materials. Ultimately, rather than a precise set of musical directives that prescribed various parameters to correspond with visuals, I wanted to make a collection of images and videos that had the potential to convey a broad spectrum of moods and behaviours— providing inspiration for developing material that would evolve organically in response to musical interactions in a live performance setting.[278]

I had the opportunity to speak with Gaona and Gómez about the audiovisual associations and crossmodal correspondences they had relied on when performing *Ember*. Describing her decision to employ particular extended techniques, Gaona remarked:

> In *Ember*, it turned out that multiphonics were associated with visuals that generated instability for me, either because the patterns were very heterogeneous or because the grayscale—though I found the instability more in the grays than in color—was not degrading. In my view, they were more "primitive." Thus, the multiphonics I associated with these visual moments in the piece are those that are unstable and often more than uncontrollable, unpredictable. Another extended technique that was very intuitive in *Ember* was noises like air sounds, key clicks, and whisperings. These correlated with visuals that were very busy. They overwhelmed my senses more because there was little negative space. I believe this reaction is closest to non-rational intuition. It's like my vocal reaction rather than an oboe-specific one. That is, in those moments, I strip away any relationship with the oboe as a musical instrument, transforming it into an amplifier of internal noises reacting to a visual impulse.[279]

[278] I didn't mind if the performers chose to create or predetermine specific audiovisual crossmodal correspondences (e.g. opportunities for temporal synchrony between audio and visual characteristics with regards to the video scores), however, I didn't want to dictate this from my vantage point as a 'composer'.

[279] Juliana Gaona, email message to author, August 20th, 2024.

Interestingly, many of the techniques that Gaona chose to use echoed the original distanced improvisations that had inspired the visuals themselves. For Gaona, it seemed that amodal correspondences, such as texture and density also played a key role in her response:

> For me, it's more intuitive to associate visual stimuli—whether light, color, or shape—with a mini sound world that exists in my memory. I feel that, particularly with Ember, the crossmodal correspondence was triggered by the textures of the images. The score is so visually rich that it allows and invites exploration of different dimensions, including texture. For example, I associated rough textures with very high pitches, unstable, shrill, and persistent—like when you rub a fork vigorously against a plate. In this case, I feel that the crossmodal correspondence operates from the relationship between timbre and visual stimuli, where timbre is not just the pitch, color, or intensity of the sound, but also an association with memory and visual, auditory, and sensory experiences.[280]

Gaona's comments indicate that her sonic interpretation was a complex amalgam of personal experience—based on memory and various multisensory associations— in combination with modal (pitch) and amodal (texture/density) crossmodal correspondences. Referencing flowing liquids depicted in the video scores, Gómez noted:

> I think [I used a] combination of reverb and delay and this other effect that's called rhythm that [creates] granular sounds. Also, in the pedal, there is an effect that is like a wawa effect…I think that brought [to mind] the watery thing [i.e. appearance of moving liquids in the video scores]. [In a different version I did] with Diego Serrano [for voice, electronics and analog synthesizer] I related the movement of the ink more with melodic sounds. I used it to create melodies that were, in some way, following the movement [of the ink], not necessarily in [an obvious] sense of "high" [on the screen] equates to "high" pitches and [vice versa]. But more like, 'this [part of the image] has a movement, and I am going to do a movement with this melody.[281]

Gómez seems to have used amodal crossmodal correspondences between motion and pitch height as a means of influencing the trajectory of her vocal melody. She was also keenly aware of relationships between her own responses to the visuals and those Gaona had formed: "I was

[280] Gaona, email message.

[281] Natalia Merlano Gómez, transcribed for concision from a zoom interview with the author, July 20th, 2024.

thinking about how the visual part [of the score] is this triggering thing. As we are listening to the other people who are playing with us, that triggers other things for us in the visuals at the same time…In some way that I think is very intuitive, we are perceiving how the other one is interpreting that graphic, and we also want to go into that world at some point."[282] Gómez's comments hint at some of the ways that different levels of sensory stimuli, both visual and auditory, influenced her musical responses in a live performance setting.

Rather than presenting physical copies of the score modules for performers to interpret, *Ember* was designed to be shared and viewed via digital means (e.g. google drive, iPad, tablet).[283] Similar to the instructions I developed for *Epistolary Transmissions*, performers were given autonomy to translate visuals into sound in whatever way felt most intuitive to them. This could manifest as a one-to-one mapping of discrete sound to image on a predetermined timeline or alternatively, reflect an atmosphere, mood or emotion. It was important to me that Gómez and Gaona had the flexibility not only to choose and organize the materials in any order they wished—including layering, editing and reconfiguring the existing scores to create composite graphic notation if desired — but to have the freedom to use the materials as jumping off points for structuring a collective improvisation.[284] *Ember* has since been reconfigured and interpreted

[282] Gómez, zoom interview.

[283] In the case of *Ember*, the choice of digital images/video was also partly a practical one. I wanted both Gómez and Gaona to have access to the scores prior to working in the same physical space and knew that due to pandemic social distancing restrictions this wouldn't be possible otherwise.

[284] See my 2022 version of Ember for amplified violin, video and electronics for an example of how one might reconfigure the scores. The live performance of this particular iteration also featured improvised amplified violin (not included in the fixed media linked here). To make the fixed video, I cropped, layered and edited still and video scores together, experimented with blend modes and adjusting playback times. Fixed electronics were created by layering and processing separately recorded improvisations for violin, radio and live-manipulated samples of standard classical repertoire (in this case a YouTube recording of Pérotin's, *Viderunt Omnes*.) in response to the original score modules using Ableton. At the time I had been experimenting with recording the output of improvising via manipulating multiple internet browser tabs simultaneously; each playing the same YouTube musical selection at various playback speeds and starting points so as to make the original sample unrecognizable. https://vimeo.com/679781477

by myself (for violin, video and fixed electronics) and by Colombian duo NMDS (Diego Serrano- analog modular synthesizers and Natalia Merlano Gómez: voice and effects pedal). Most recently it has been performed and recorded in Bogotá, Colombia (July 17, 2024) by an acoustic quartet: Natalia Merlano Gómez-voice, David Aguila-trumpet, Juan Camilo Vásquez-melodica and María Fernanda Rodríguez- bass clarinet (forthcoming album release on Bogotana Records, November 2024).

3.3. Live Projections in Practice: Experiments in Light and Liquids

My first hands on experience with collaborative live audiovisual improvisation evolved from a duo with my partner, composer/performer Joseph Bourdeau. The impetus behind our creative project was a desire to develop a collective improvisatory language through merging our respective interests; my research into the history of analog techniques used in liquid light shows and Joseph's established improvisatory practice integrating analog feedback with live electronics, radio, sampling techniques, percussion and electric guitar. Our sessions took place every few weeks over the course of several months in the fall of 2022 and winter of 2023. The realm of analog projections was new for me, and I wanted to use our collaboration as a chance to develop and test out various materials and techniques I had learned through my research. Using a single overhead projector, I divided my technical experiments into three main categories: light and shadow play, layered transparencies and liquids.

Light and shadow play involved creating patterns out of shadows—both abstract and referential — by manipulating paper packing materials, plastic stencils and organic matter (e.g. twigs, leaves etc.). Experimenting with the placement of objects at various distances from the glass projection stage and/or adjusting the focus of the condenser lens (see Figure 3.7 for diagram of an overhead projector) allowed me to vary the sharpness and density of the projected

shadows (e.g. raising an object or part of an object off of the glass projection stage and closer to the projecting lens resulted in shadows that were less sharp and more diffuse than those created by placing the object directly on the surface). I developed a process of working with duplicate pairs of plastic craft stencils— sliding them back and forth to create shifting geometric patterns sometimes known as counterchange patterns (see Figure 3.8). My experiments were inspired by moiré—a technique light show artists took advantage of to create psychedelic interference patterns through overlaying and manipulating two identical transparencies— as well as VJ Sue-C's use of duplicate handmade text and number stencils to effect a kind of analog 'delay' or 'echo' through shifting configurations of positive and negative space.[285] Using stencils rather than transparencies meant that the negative space could be easily filled with other content such as liquid projections or transparencies without sacrificing clarity of the projection (see Figure 3.8).[286]

[285] The word moiré comes from the French "watered." Moiré patterns or the moiré effect is a kind of interference pattern generated by "the mechanical interference of light by superimposed networks of lines. Such a pattern is formed whenever a repetitive structure, such as a mesh, is overlaid with another such structure. The two structures need not be identical. There is evidence that the effect was noted in ancient times. Modern examples that are easily observed include the effect when two layers of coarse textile are brought together, the bars observed on television when the scene includes a striped shirt or a building with regular joins, and the pattern seen through two rows of mesh or a picket fence from a distance." (Boone, 2001, p.3)P. M. Boone, "NDT Techniques: Laser-Based," in *Encyclopedia of Materials: Science and Technology*, ed. K. H. Jürgen Buschow et al. (Oxford: Elsevier, 2001), 3, https://doi.org/10.1016/B0-08-043152-6/01059-7.

[286] I quickly discovered that there was a limit to how many layers of transparent materials —either liquid, glass or acetate— could be stacked on top of each other on the projection stage before the focus and clarity of the projected image was affected. Using two overlapping transparencies with similar patterns rather than stencils meant that the negative space would already contain two layers of acetate and likely blur the content of any additional layers I might want to include.

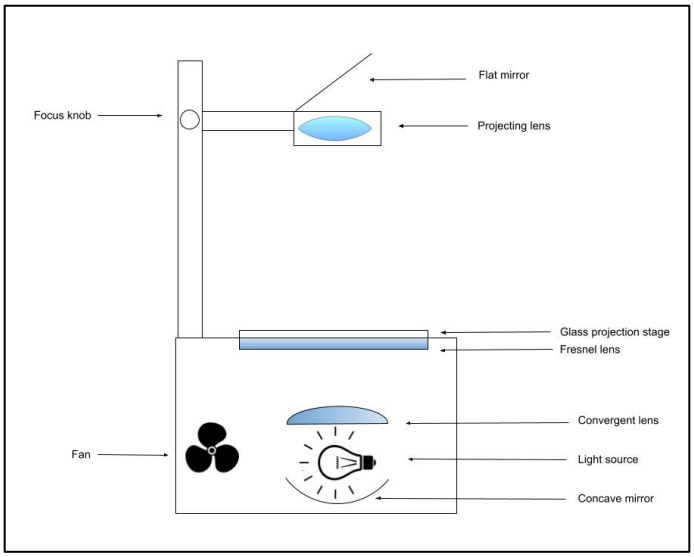

Figure 3.7: Diagram of an overhead projector

Figure 3.8: Still from footage of an improvisation made using plastic stencils and a handheld prism (left), and layered transparencies (right).

Transparencies were a simple way to incorporate supplementary layers of visual content.

I was primarily interested in adding textures that could be manipulated independently and used in

concert with liquids and light/shadow play. For my collaboration with Joseph, I made a series of transparencies by scanning images taken from vintage National Geographic magazines and manipulating them in photoshop. Typically, the photographs I chose were derived from nature or scientific imaging and were unintentionally abstract (e.g. topographical maps, landscapes, or thermograms). Connecting back to my interest in indeterminacy and long exposure photography, I also created transparencies by distorting original mixed media artwork I had made for other purposes and warping it via a digital flatbed scanner. A technique common to Scanography, I moved the artwork on the scanner bed while it was being scanned —the results of which are not unlike photographic light trails captured through long exposure times.[287]

The first liquid I worked with was water. Surprisingly, even a relatively weak overhead projector is able to capture subtle changes in surface tension. Simply pouring water into a clear glass petri dish set on the projection stage creates ripples and waves that are visible on the screen. In order to introduce color into my experiments, I looked to the history of light shows for inspiration. As discussed in Chapter 2, despite the fact that light shows of the 1960s utilized a complex network of materials and media (e.g. Single Wing Turquoise Bird, Joshua Light Show), they often remain primarily associated with a visual aesthetic characterized by colorful psychedelic patterns of swirling liquids. Light show practitioners worked with liquids of varying

[287] "Scanography, also spelled Scannography and referred to as Scanner Art or Scanner Photography, is the name for a process to create digital images using a flatbed scanner in a way the manufacturer hasn't initially planned". Artists working in this medium, often take advantage of the high resolution but low depth of field of flatbed scanner technology to scan small 3D objects.“Scanography - Introduction :: LaserSoft Imaging,” accessed August 3, 2024, https://www.silverfast.com/show/application-scanography/en.html.; Scanography is an offshoot of Xerox art, pioneered by artists like, Hudinilson Jr., Barbara T. Smith, Helen Chadwick and Sonia Landy Smith who founded the Generative Systems program at the School of the Art Institute of Chicago in 1970. The GS program was dedicated to exploring "creative possibilities of new technology,” using devices such as the ColorIn-Color, Thermo-Fax, 3-M VQC, telecopier, and Haloid Xerox.Diane Kirkpatrick, “Sonia Landy Sheridan,” *Woman’s Art Journal* 1, no. 1 (1980): 4, https://doi.org/10.2307/1358020.; Zanna Gilbert, “The Untold Story of Xerox Art and Its Bold Female Pioneers | Getty News,” Getty, April 13, 2023, https://www.getty.edu/news/the-untold-story-of-xerox-art-and-its-bold-female-pioneers/.

densities, most commonly: oil (typically mineral), water, and alcohol, in combination with oil dyes and various water-based pigments.[288] While many specifics of lightshow techniques remain closely guarded, I found several helpful websites and YouTube tutorials, which provided practical insight into how some of these iconic effects were produced.[289] By virtue of the fact that liquids were manipulated in relatively shallow glass receptacles, categories of liquid interactions were called 'plates' by light show artists (e.g. squash plates, blow plates). Squash plates consist of colored liquids sandwiched between two glass plates—clock glass was/is used typically because of its relative thinness and shallow curvature; blow plates are created by using air (e.g. drinking straw or electric fan) to activate various liquids in a single glass dish. While I experimented with both kinds of plates, I was primarily interested in combining liquids with other objects/transparencies. Squash plates necessitate the use of two layers of glass which I found tended to obscure the clarity of textural detail that I was trying to achieve.[290] Consequently, I worked primarily to create blow plates with a single petri dish and various liquids— mineral oil, water, alcohol, glycerin and different kinds of dyes.[291]

As I became more experienced, I learned to integrate techniques from multiple categories together (e.g. liquids with transparencies and plastic stencils). In all three categories, I frequently

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[288] In order for color to show up in the projections, dyes and liquids needed to be highly pigmented, but also transparent.

[289] Steve Pavlovsky, "Liquid Light Lab," accessed August 2, 2024, https://liquidlightlab.com/home.html; "pOoTers pSycheDelic shAcK - The Rabbit Hole," accessed July 24, 2024, https://www.pooterland.com/lightshow_rabbit_hole.html. Light artist Steve Pavlovsky's website "Liquid Light Lab" is both a practical and archival resource including links, interviews and instructional videos that I found especially helpful in providing tips to get started. Pooterland, is a database. Pooterland is a database and online archive dedicated to: "....Psychedelia, Acid Rock, Progressive Rock, Garage Bands, 60's Punk, Krautrock, Freakbeat, wig-lifting rarities, Books, Posters, Light Shows and other **STRANGE** items related to pSycheDelic music..."

[290] In the future, combining multiple projectors and having a more powerful wattage of bulb would likely help to alleviate this issue.

[291] Steve Pavlovsky's tutorials introduced me to a technique of using dye with glycerin to create dendritic patterns.

used handheld prisms designed for photography to further modulate and refract the light being projected. For the most part, since Bourdeau and I were using our improvisations as an opportunity to develop new working methods and audiovisual relationships, we didn't typically plan out what we were going to do beforehand. After a few sessions however, we realized that due to practical constraints, [292] it was helpful to loosely map out a trajectory of techniques in order to aid the smoothness of transitions from one to another and to add musical structure—something that was particularly helpful for improvisations that were longer than fifteen minutes. Just as in any instrumental partnership, spending time practicing together was key to cultivating a collaborative lexicon and working method. To facilitate this process further, we recorded our experiments for archival purposes. Not only did reviewing the footage provide us with a sense of our collective pacing and flow—something that was hard to determine during the course of the improvisation itself— but it also gave us a glimpse into how the various audio and visual elements came together to create an audiovisual experience.[293]

During our improvisations, I found myself primarily relying on amodal crossmodal correspondences (e.g. periodicity, relative density, texture and temporality) to create relationships between audio and visual components rather than crossmodal ones (e.g. as hue and pitch). Bourdeau's audio consisted of a variety of materials: "I was sampling from an AM/FM radio, as well as playing instruments like electric guitar, percussion and recorder. All of these sound sources could be looped or processed with reverb in Ableton Live, and a lot of my process

[292] For example: the inherent messiness of working with liquids and the preparation involved in setting up microphones for analog audio feedback.

[293] For example, from reviewing footage, I learned to avoid 'dead spots' —a term I used to describe moments of unintentional pause when nothing appeared to be happening on the projection screen. I found that 'dead spots' were usually caused by technical constraints (i.e. difficulty of moving a plate of liquids quickly off the projection stage). I also learned that using space and breath to guide pacing and gesture when manipulating various materials, just as in a music, is an important tool to create structure and dialogue within the improvisation.

involves mixing these different elements together into dense, overlapping collages of sound."[294] Certain kinds of slowly evolving audio processes—looping for example—paired especially organically well with introducing colored oil dyes to water and watching them spread and fragment across the surface. Using the same plate, I could also create correspondences between rhythmic musical loops and visuals by positioning a portable desk fan to automate the movement of oil dye, breaking it down into smaller droplets with each subsequent spin around the petri dish. Reflecting back on the experience, Bourdeau recounted exploring similar correspondences between density, texture and temporality:

> In particular I remember responding to density and patterns of motion when you were working with liquids. A lot of the music was live-sampling from the radio and live-looping with percussion and guitar, and I remember piling on more layers of loops as the inks became more dense over time. I also remember the inks having particular patterns of motion like slow churning, which I would try to loosely correlate with things like loop speed. I think also the fact that we were both working with layers of discrete elements in different ways helped. So if you have a slowly churning plate of inks, where the surface is being rippled quickly by a fan, or droplets of ink are being dynamically added you have fast and slow motions occurring together visually. Those are things I might respond to musically with a slower, more periodic behavior, and a faster, more turbulent one simultaneously. That's not terribly specific, but in my mind it wasn't very specific at the time. I remember taking what you were doing in as a set of behaviors that I would then try to reinforce or complement musically, so that together the two created an environment that felt natural and functional.[295]

Other specific correspondences I explored included adjusting focus to deliberately blur the projection image in response to audio effects such as reverb or delay. I accomplished this by using a hand help prism or various components of the projector to adjust the density and speed of visual distortion of a given projection in order to correspond or contrast with the relative density

[294] Joseph Bourdeau, email message to author, July 28th, 2024.

[295] Bourdeau, email message.

and speed of various temporal elements in the music.[296] Given that Bourdeau is someone who regularly incorporates visuals (both live and fixed) into his creative practice, I was curious to find out if and how the process of correlating audio to visuals in a collaborative setting differed from Bourdeau's own working method:

> In a lot of ways, it was very familiar. One of the ways I use visual elements in my own work is through generating video feedback, and then correlating audio to that video, either live or prerecorded. So, in a general sense I think watching visuals and responding to them musically was a familiar process. On another level video feedback has its own behaviors that you can guide and work with, but that you don't take complete control over it really. In those situations, I set initial parameters to create a loose set of potential behaviors the system can enact, and I adjust things dynamically in response to the ways those behaviors actualize in real time. It's kind of a living system, and so I think responding to something that has its own behaviors that are to an extent external to myself was a process I had a degree of familiarity with. That's not the same as a duet obviously, because that video has much less agency than you as a performer do, but the processes are related in my mind.[297]

While Bourdeau and I haven't had an opportunity to perform together in a live setting, I have subsequently been able to incorporate some of the technical skills I developed during our creative partnership into other projects. Most recently, I performed as a visualist on Camilo Zamudio's DMA recital (March 11th, 2024, at the University of California San Diego, Conrad Prebys Music Center Experimental Theater) where I designed analog visuals to pair with *Flying Bear* (2014), ritual music for solo percussion by UC San Diego professor Wilfrido Terrazas (b. 1974) and Ritmología by Jesús Pinzón Urrea (1928-2016) featuring movement by Babay L. Angles (see Figure 3.9).

[296] Blur was accomplished either via adjusting the focus wheel directly, or by changing the placement of individual materials relative to the Fresnel lens and projection stage.

[297] Bourdeau, email message.

Figure 3.9: Camilo Zamudio, percussion, performing Ritmología by Jesús Pinzón Urrea with improvised movement by Baby L. Angles and live analog projections by Ilana Waniuk. Photo credit: David Aguila.

3.4 Archive

Archive is an ongoing modular, audiovisual project exploring memory, ritual and connection. Created in collaboration with flutist and improviser Teresa Díaz de Cossio, *Archive* consists of a series of modules—*artifacts*— intended to be used as invitations for collaborative audiovisual improvisation and experimentation. I was inspired by the idea of opening a box of old photographs, memorabilia, and ephemera such as one might find at an archive—each linked to a distinct network of memories. How might those intangible connections be brought to life and explored through the medium of audiovisual performance? Acknowledging the work of mid 20th century artists who incorporated the motif of a case or box along with various everyday objects and materials into their work —George Brecht, *The Case* (1959), Marcel Duchamp's *Box in a*

Valise (1935-41), and Joseph Cornell's boxed assemblages. Rather than incorporate a physical case or box, my intention with *Archive* has been to develop a more overtly personal approach incorporating both intermedial and multimedia elements into the performance. *artifacts* take the form of improvised digital and analog projections, video scores, graphic or text scores, audio files (digital/tape) and objects. To date, *Archive* consists of four *artifacts* and has grown out of two branches of my current artistic practice: explorations into improvisational audio/visual performance practices and modular graphic scores with a collaborative, network or transmission art component.[298]

Materials for the current iteration of *Archive* have been generated and/or inspired by digital photos, videos and field recordings that I invited Díaz de Cossio to gather as a kind of personal archive in July 2022 (Portugal), and October 2023 (Ensenada, Mexico). The first workshop performance of *Archive* showcasing four *artifacts* took place at the University of San Diego California's Experimental Theater (Feb 3rd, 2024). Using memory as a starting point, each *artifact* is designed to allow Díaz de Cossio, and myself to dialogue, engage and improvise with each other using a variety of different modalities and materials. Although the structure I've created has been inspired by Díaz de Cossio's original materials, I have purposefully built a level of flexibility, ambiguity and chance into the process by permitting my own experiences, identity and artistic sensibilities to guide my responses to her materials and the subsequent improvisatory systems/structures that I have established for each component of the work. My hope is that by doing so, Díaz de Cossio and I will be able to enact a kind of responsorial feedback loop that will allow us to connect and reconnect with each other and the materials in related but infinitely

[298] Our intention with this project is to continue to collaboratively create *artifacts* to expand the *Archive*. Ultimately allowing us to configure materials into performances of various lengths (e.g. thirty to sixty minutes). Having flexibility will allow us to keep practical considerations in mind and facilitate ease of performance -depending on venue/context.

varied ways for each performance iteration. In keeping with my desire to create work which deliberately engages with performance as a medium in a multi-sensory way, the audiovisual materials/structures I have predetermined are designed to allow us to build a specific scenography for many of the *artifacts* through the manipulation of sound, image, light and shadow.

artifact I is intended to welcome audience members into the archive. Inspired by videos Díaz de Cossio collected while in Portugal in July 2022, audio for *artifact I* consists of a series of early morning field recordings taken in Mexico and Portugal— in dialog with free improvisations created by manipulating amplified household objects (porcelain cups, saucers, glasses, cutlery) with a contact mic and processing the results using simple effects built into a mini amp (e.g. delay, distortion).[299] The pacing and rhythm of visual and sonic improvisations are intended to evolve gradually and organically over the course of the six to seven minute module. Staged to appear as if sitting by a window, Díaz de Cossio remains seated at a small table for the majority of the artifact (see Figure 3.10).[300] White gauze curtains mounted on a scaffold and activated by means of an oscillating fan, function as a literal and metaphorical window for audiences to engage with the abstract visuals while simultaneously serving as a gently undulating projection surface for images generated using two overhead projectors, transparencies, vintage fabric, oil and water-based dyes, water, glass sheets and prisms/lenses. I chose to work solely with analog projections for this module, drawing on techniques derived

[299] I manipulated the recordings in Ableton using simple effects such as delay, echo, and reverb to tie back to the theme of memory. Namely, that each time you return to a memory it shifts further from the actual experience. In this context, I considered echo, delay and reverb to be a more literal crossmodal example of this iterative process.

[300] Díaz de Cossio described the experience as akin to "revisiting a memory where time reveals new perspectives and meanings. *artifact I* was designed as a window, and the curated objects—beautiful tea sets, colorful tiles, and embroidered tablecloths—transported me to a very intimate space." Teresa Díaz de Cossio, email message to the author, August 26th, 2024.

from liquid light shows discussed in section 2.2—namely transparencies, light and shadow and liquids.

Figure 3.10: Still images showing the staging and set up for *artifact I* taken during the workshop performance and dress rehearsal on Feb 3rd in UCSD's Experimental Theater.

Audio for *artifact II* dialogues freely improvised bass flute with a fixed audio track composed of lightly processed field recordings gathered in places of worship in Portugal layered with home recordings of striking matches and sputtering candles. Abstract visuals inspired by light play through stained glass windows and candlelight are generated during the performance by digitally layering, mixing and affecting premade footage with a live camera feed and further processing them using simple effects in Max mapped to a midi controller (e.g. delay, feedback and various blending modes).[301] Source visuals were created by using a DSLR camera to capture

[301] Max (also known as Max/MSP/Jitter) is a visual programming language primarily designed for music and multimedia. The specific effects I used were configured via a series of interconnected VIZZIE modules.

footage of stacked white plastic stencils filmed against a black background and activated by moving prisms in front of the camera lens or sliding the sheets back and forth.[302] Video files were subsequently combined and edited in post-production by layering, splicing and applying various blending modes. To evoke a sense of flickering, I blended real-time soft-focus camera footage of colored string lights that I manipulated by hand. Fixed audio for *artifact II* is loosely structured, insofar as I have selected and predetermined the order and length of field recordings serving as a base for Díaz de Cossio's improvisation. However, the style, form and musical content of the improvisation, is left completely up to Díaz de Cossio's discretion and creative vision.[303] That being said, most iterations to date have featured relatively spare, modal melodic material—bringing to mind a soliloquy or prayer. To suggest a cavernous and dimly lit architectural space, reminiscent of some of the original source materials, live and fixed audio are processed using generous amounts of reverb. Díaz de Cossio stands within the frame of the projection surface to create the impression of being immersed in the kaleidoscopic visuals, while I remain situated at a separate table somewhat apart from the mise-en-scene to reinforce the illusion that Díaz de Cossio is alone with her thoughts (Figure 3.11).[304]

[302] See my notes about using this technique to generate animated counterchange patterns in the previous section.

[303] The only restriction being that Díaz de Cossio's improvisation needs to fit within the timeframe of the fixed audio track.

[304] Ideally front, rather than rear projection would be used. Unfortunately, for practical reasons, we were not able to use front projection for this movement during the Feb 3rd workshop performance.

Figure 3.11: Still showing Flutist Teresa Díaz de Cossio performing artifact II. Extracted from dress rehearsal footage for the workshop performance on Feb 3rd, 2024. University of California San Diego, Experimental Theater. Videographer: Robbie Bui

Audiovisual source materials for *artifact III* were derived from and generated using a text score which prompts performers to create a palimpsest-esque text based on the ritual fragmentation of a memory:

> think of a memory that you would be willing to share with others in an abstracted form
>
> write your memory down on paper (any kind) using a pen (can be a ballpoint pen or something similar)
>
> shortly afterwards…
>
> gather a paint brush (any kind) and a glass of water
>
> use the brush and water to blur out and obscure various words and phrases from the memory you have written down on paper until only a few fragments remain.
>
> let dry….[305]

[305] Ilana Waniuk, "artifact II" (unpublished score, 2023).

I used field recordings collected by Díaz de Cossio in response to the prompt—sounds of writing with pen on paper and waves crashing on a rocky beach— as raw materials to build a fixed audio track using Ableton. Inspired by the periodic rhythm of the field recordings, I composed a series of slowly evolving melodic patterns to be performed on an amplified 30 note hand crank music box in tandem with an effects pedal. Through turning the crank at variable speeds, Díaz de Cossio could control the timing of pitched material as well as the ability to adjust the placement of the contact microphone and manipulate various parameters of the effects pedal (e.g. reverb, echo, overdrive, feedback).[306] Underscoring the module is a six-minute fixed audio track made by layering the aforementioned field recordings with pre-recorded samples of music box material. Connecting back to the iterative process of remembering, I experimented with pitching the pre-recorded music box material down/up by different microtonal amounts (e.g. syntonic comma, Pythagorean comma, quarter tone) to create the potential for interference beating between fixed and live audio.[307] Echoing the form and function of the music box roll, I fabricated a series of paper strips of various lengths to be passed by hand under the lens of a digital microscope camera.[308] Each paper strip consists of abstracted imagery derived from transcribing and obscuring text fragments of Díaz de Cossio's palimpsest using India ink and wax resist (see Figure 3.12). Live video was further processed by using effects in Max (e.g. delay, feedback,

[306] The music box is mounted to a small hollow wooden box to help with projection and resonance. By moving the placement of the contact mic to various locations— both on the instrument and in and around the box—Díaz de Cossio is able to significantly affect the tone and timbre of the sound.

[307] A syntonic comma represents the interval ratio of 81/80 which roughly corresponds to 21.5 cents, while the Pythagorean comma is slightly wider, representing a ratio of 531441/524288, roughly 23. 46 cents and quarter tone 50 cents (please see section 1.14 for a more in-depth explanation of interference beating). My intention with using this technique was to explore the inherent discord between an event and our remembered impression of it.

[308] Using horizontally oriented strips allowed me to manipulate the moving image with greater ease. Similar to running film through a projector, by sliding the strips underneath the camera lens, I had the capacity to create a moving sequence of abstract imagery via manipulating the strip at variable speeds. Longer strips permitted ease of movement without having to reset my hands or necessitating frequent changes from one strip to the another (unless motivated by artistic decision making).

blend modes), and layering top-down imagery of crashing waves (Black's Beach, La Jolla, CA) with real-time footage of India ink spreading via dendritic patterns on wet watercolor paper. The overall color scheme was relatively monochromatic, reflecting the ink and paper used by Díaz de Cossio in her original response. To further modulate the camera feed, I placed mirrors between the camera lens and paper strips, resulting in a basic kaleidoscopic effect. Audiovisual structure was improvised freely in response to the audio by using these materials and methods. Visuals were projected on a series of overlapping sheets of white cardboard mounted on poster stands of varying heights, as well as a white tablecloth, the paper music box roll and Díaz de Cossio's white clothing (see Figure 3.13). My intention by breaking up the flat projection surface through discrete layers of varied depth, was to create the illusion of situating Díaz de Cossio within a variable landscape of shadow and light.

Figure 3.12: Sill image showing Ilana Waniuk manipulating paper strips used in artifact III. Taken during the dress rehearsal for the workshop performance on Feb 3rd, 2024. Photo credit: Robbie Bui. University of California San Diego, Experimental Theater.

Figure 3.13: Still image showing Teresa Díaz de Cossio performing with amplified music box and pedal in artifact III. Taken during the dress rehearsal for the workshop performance on Feb 3rd, 2024. Photo credit: Robbie Bui. University of California San Diego, Experimental Theater.

artifact IV is a fixed video score intended to serve as inspiration for a duo improvisation for flute and violin.[309] Visual materials for *artifact IV* evolved from photos of patterned Azulejo tiles and video clips Díaz de Cossio took from the window of the passenger seat during a road trip in Portugal (June 2022).[310] The hypnotic rhythm of clouds and treetops with converging

[309] In future iterations, I intend to experiment with creating live projections based on visual materials derived from the same sources mentioned below.

[310] M. Pereira et al., "Ancient Portuguese Ceramic Wall Tiles ('Azulejos'): Characterization of the Glaze and Ceramic Pigments," *Journal of Nano Research* 8 (September 2009): 79, https://doi.org/10.4028/www.scientific.net/JNanoR.8.79. Azulejo are decorative ceramic tiles originally used to

power lines in turn reminded me of childhood trips, watching the outside world unfold, while being framed by the backseat window. To make the fixed video, I used Premiere Pro to layer and process Díaz de Cossio's source materials with colorful abstract footage intended to represent the aforementioned childhood memories (see Figure 3.14).[311] For the Feb 3rd, workshop performance, Díaz de Cossio and I were positioned in front of the projection screen so that the video would serve as a moving backdrop to our improvisation. The score included glimpses of representational footage (e.g. trees, clouds, bridges) alluding to the world speeding by outside the concert hall— the use of rear projection helped to emphasize this impression by setting our bodies apart from the moving images on the screen. Musically, our duet was completely unplanned. Since Díaz de Cossio is such an accomplished improviser and frequent collaborator, I opted not to include fixed instructions for how to interpret the video. Rather, I relayed my intentions orally, through informal discussion during rehearsal. I wasn't interested in creating an improvisation based on synchronous responses to individual visual elements in the video, rather I hoped the various textures and imagery would serve to set a mood that we could explore freely together albeit over a fixed duration (ca six minutes).

decorate monasteries, churches and palaces in Portugal from the 15th to 18th century. More recently, azulejo have become a ubiquitous element of design in Portugal and can be found in homes, and public buildings around the country.

[311] I remember passing the time by shutting my eyes and watching colors play behind my eyelids— in vibrant contrast to the greenery of the landscape in Southern Ontario where I grew up. To emulate a flickering effect in the video score, I incorporated raw footage leftover from making *Within Worlds* (see section 1.14).

Figure 3.14: Still showing Teresa Díaz de Cossio (flute) and Ilana Waniuk (violin) performing artifact IV. Taken during the dress rehearsal for the workshop performance on Feb 3rd, 2024.Videographer: Robbie Bui. University of California San Diego, Experimental Theater.

Connecting back to my original concept for the collaboration, I wanted the music and visuals in *Archive* to work in concert with each other in order to evoke a specific and self-contained atmosphere for each *artifact*. For *artifact I*, rather than modulate characteristics of my visual improvisation in response to various parameters in de Díaz de Cossio's improvisation, I primarily explored relative temporal correspondences tied to the drones in the fixed audio track (e.g. slowly moving liquids or slow fragmentation/blurring of the projected image using a handheld prism).[312] Similarly, Díaz de Cossio didn't create sounds to respond to the visuals

[312] In this instance visual blur corresponded to audio effects such as reverb and echo which featured prominently in the fixed audio track. Tying back to *Ember*, and my light show experiments with Joseph Bourdeau detailed in the previous section.

directly (i.e. she didn't strive to create a one to one relationship between sound and visuals). Instead, she aimed to depict a particular mood: "As I observed the projection of liquids, I felt a sense of exploration, focusing on tiny sounds and using minimal [sonic] material."[313] In *artifact II*, improvised visuals were modified in response to textural shifts in the fixed audio or Díaz de Cossio's improvisation. For example, I formed correspondences between textures in the fixed audio (e.g. density of crackling in fixed media was sometimes mapped to the speed and density with which I manipulated the colored string lights) or to changes in speed, and texture of the melodic material in the improvisation. I used soft focus and delay as visual effects to correspond with reverb in the audio track and in Díaz de Cossio's amplified sound. The overall aesthetic of the module also relies on general correspondences between brightness and pitch (e.g. low register of the bass flute pairs with the dark colors in the fixed and live visuals). Díaz de Cossio's experience differed from mine due to her placement relative to the projection screen: "Unlike other movements [*artifacts*], I couldn't see the visuals live, but I had an intuitive sense of what was happening. I imagined the shapes and the particular color palette being used as a template for my improvisation. The nature of the improvisation here felt like a soliloquy—while [I was] aware of the changing world, [I] couldn't fully see it but still sensed its presence."[314] Her responses were guided by imagined impressions of crossmodal correspondences— primarily between dark colors and low pitches. Audiovisual correspondences in *artifact III* were frequently amodal and based on changes in texture and density. I used temporal correspondences (e.g. duration of musical phrases) and shifts in density—such as increasing tempo of music box material—to correspond with increasing speed of movement in manipulation of paper strips

[313] Teresa Díaz de Cossio, email message to the author, August 26th, 2024.

[314] Díaz de Cossio, email message.

under the camera. Visual delay (via Max), and audio delay (using the effects pedal) also featured prominently in the module— though not in exact synchrony with each other. Rather, rhythmic iterations of delay in both media served to create a kind of counterpoint between visuals and audio. Textural correspondences also linked jagged abstract shapes with noisy audio effects such as distortion and fuzz. Díaz de Cossio primarily used amodal correspondences such as texture and speed: "In *artifact III,* visuals were projected onto panels, and although I was facing away from them, I could perceive them through the projection on my white dress. The quality of these projections influenced the pacing of the paper rolls [for the music box]."[315] Unlike other modules, the use of fixed video in *artifact IV* meant that correspondences between improvised visuals and music weren't generated live, however, the inverse was certainly true especially with respect to amodal correspondences like texture and temporality. Since the score itself is a complex network of overlaid visual components, it wasn't intended to serve as a means of generating an improvisation through forming temporally mediated correspondences between specific sequences of imagery and musical characteristics (even especially arcane ones as in Cardew's *Treatise*). Similar to *Ember*, I hoped that the images would function instead as a jumping off point for an improvisation by suggesting mood, atmosphere and energy. The score conveyed the impression of speed through movement of imagery across the screen, which Díaz de Cossio and I attempted to emulate through incorporating a generally frenetic sense of energy into our playing. This was an unplanned artistic decision, which manifested through several musical characteristics: sharp articulations, rapidly moving melodic figuration, frequent use of crescendi and moderate to loud volume. Although the video score includes rapid changes in color and textures, the pacing remains relatively steady throughout. Díaz de Cossio and I tapped into this

[315] Díaz de Cossio, email message.

sense of monotony, albeit a high octane one, by using pedal tones performed at relatively high volume within our improvisatory dialogue. Ultimately, my approach to crossmodal correspondences in *Archive* relied on prior experimentation and improvisation to predetermine specific palettes of effects, materials and techniques in order to create the impression of an integrated audiovisual microcosm for each *artifact*.[316]

[316] To view short video clips of the dress rehearsal for the workshop performance of *Archive* please see video files labeled: 3D_artifact I.mp4, 3E_artifact II.mp4, 3F_artifact III.mp4, 3G_artifact IV.mp4. Videography by Robbie Bui, audio was taken from the house mix recorded by Jeremy Olsen at the University of California, San Diego, Experimental Theater, Feb 3rd, 2024. Teresa Díaz de Cossio, flute and objects, Ilana Waniuk, visuals and violin.

CONCLUSION

> The act of musicking brings into existence among those present a set of relationships... not only between the humanly organized sounds... but also in the relationships that are established between person and person within the performance space. These relationships stand in turn for relationships in the larger world outside the performance space... between individual and society, humanity and the natural world and even the supernatural world as they are imagined to be by those taking part in the performance. Those are important matters, perhaps the most important in human life.
>
> — Christopher Small

In this document, I have undertaken an examination of crossmodal perception, through a discussion and comparison of synesthesia and crossmodal correspondences grounded in research drawn from the field of experimental psychology. With respect to synesthesia, I have attempted to differentiate the neurological phenomenon from the "ideal of synesthesia" which had such a profound influence on music and visual arts at the turn of the century. Artistic branches such as abstract art, absolute film, and Light Organs, developed from exploring various crossmodal correspondences between sound and image, paving the way for live audiovisual performances to come (e.g. Liquid light shows, Expanded Cinema, Video Art, Computer Art and VJing). It was beyond the scope of my discussion to touch on all the aforementioned genres, but it is worth noting the connection to the "ideal of synesthesia" from which these varied lineages emerged.

It was important to me that my research include conversations with contemporary artists working in the realm of audiovisual performance. Through my interview with visualist Akiko Nakayama, I was able to ask her about the evolution of her collaborative practice and the various ways that crossmodal correspondences manifest in her work. In the realm of liquid visuals, techniques and methodology often remains closely guarded and I feel very lucky to have had the

opportunity to gain a deeper understanding of the way that liquids, fluid dynamics and color interface with music within the context of her work.

In Western classical music, crossmodal correspondences play a key role, with respect to notation. My focus on graphic notation in this document, through my own works as well as those of Hallock-Greenewalt, Cage, Cardew, and Brecht connects back to my evolving audiovisual performance practice and a desire to break free of delineations between composer and performer that have been so prevalent in Western classical music for the past 200 years. While I hold great respect for the artists who identify as composers, I feel uncomfortable adopting the term to describe my role in the creative process. With reference to the quote above from Christopher Small, I prefer instead to cultivate a practice which explores relationships between performers, between sound and visuals, and between the tangible and ephemeral. By doing so, I hope to forge relationships that open up artistic collaborations to "the larger world outside of the performance space."

BIBLIOGRAPHY

Abbado, Adriano. *Visual Music Masters: Abstract Explorations: History and Contemporary Research*. Milano, Italy: Skira Editore S.p.A., 2017.

Albertazzi, Liliana, Luisa Canal, and Rocco Micciolo. "Cross-Modal Associations between Materic Painting and Classical Spanish Music." *Frontiers in Psychology* 6 (2015): 424. https://doi.org/10.3389/fpsyg.2015.00424.

Alexander, Amy, and Nick Collins. "Live Audiovisuals." In *The Cambridge Companion to Electronic Music*, edited by Julio d'Escrivan and Nick Collins, 2nd ed., 123–37. Cambridge Companions to Music. Cambridge: Cambridge University Press, 2017. https://doi.org/10.1017/9781316459874.009.

Allen, Keith. "Blur." *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 162, no. 2 (2013): 257–73.

American Psychological Association. "APA Dictionary of Psychology." Accessed July 30, 2024. https://dictionary.apa.org/percept.

Analogue Wonderland. "The History and Evolution of Lomography." Accessed July 22, 2024. https://analoguewonderland.co.uk/pages/lomography.

"APA Dictionary of Psychology." Accessed August 1, 2024. https://dictionary.apa.org/photism.

"APA Dictionary of Psychology." Accessed August 1, 2024. https://dictionary.apa.org/photopsia.

"APA Dictionary of Psychology." Accessed August 1, 2024. https://dictionary.apa.org/perception.

Backus, John. "Multiphonic Tones in the Woodwind Instruments." *The Journal of the Acoustical Society of America* 63, no. 2 (February 1, 1978): 591–99. https://doi.org/10.1121/1.381758.

Barnett, Kylie J., Ciara Finucane, Julian E. Asher, Gary Bargary, Aiden P. Corvin, Fiona N. Newell, and Kevin J. Mitchell. "Familial Patterns and the Origins of Individual Differences in Synaesthesia." *Cognition* 106, no. 2 (February 2008): 871–93. https://doi.org/10.1016/j.cognition.2007.05.003.

Baron-Cohen, S., L. Burt, F. Smith-Laittan, J. Harrison, and P. Bolton. "Synaesthesia: Prevalence and Familiality." *Perception* 25, no. 9 (1996): 1073–79. https://doi.org/10.1068/p251073.

Beeston, Alix. "Blur." *Modernism/Modernity Print Plus* 7, no. 1 (2022): 1–6.

Belyk, Michel, and Steven Brown. “Perception of Affective and Linguistic Prosody: An ALE Meta-Analysis of Neuroimaging Studies.” *Social Cognitive and Affective Neuroscience* 9, no. 9 (September 1, 2014): 1395–1403. https://doi.org/10.1093/scan/nst124.

Bertelson, Paul, and Béatrice de Gelder. “The Psychology of Multimodal Perception.” In *Crossmodal Space and Crossmodal Attention*, edited by Charles Spence and Jon Driver, 141–77. Oxford University Press, 2004.

Betancourt, Michael. *Mary Hallock-Greenewalt: The Complete Patents*. Wildside Press, 2005.
———. “Mary Hallock-Greenewalt’s ‘Abstract Films.’” *Millennium Film Journal*, October 1, 2006. https://www.academia.edu/111505719/Mary_Hallock_Greenewalts_Abstract_Films.

Bhattacharya, Joydeep, and Job P. Lindsen. “Music for a Brighter World: Brightness Judgment Bias by Musical Emotion.” *PLoS ONE* 11, no. 2 (2016). https://doi.org/10.1371/journal.pone.0148959.

Blum, Stephen. “Representations of Music Making.” In *Musical Improvisation: Art, Education, and Society*, edited by Gabriel Solis and Bruno Nettl, 239–62. University of Illinois Press, 2009.

Bonetti, Leonardo, and Marco Costa. “Pitch-Verticality and Pitch-Size Cross-Modal Interactions.” *Psychology of Music* 46, no. 3 (May 1, 2018): 340–56. https://doi.org/10.1177/0305735617710734.

Boone, P. M. “NDT Techniques: Laser-Based.” In *Encyclopedia of Materials: Science and Technology*, edited by K. H. Jürgen Buschow, Robert W. Cahn, Merton C. Flemings, Bernhard Ilschner, Edward J. Kramer, Subhash Mahajan, and Patrick Veyssière, 6018–21. Oxford: Elsevier, 2001. https://doi.org/10.1016/B0-08-043152-6/01059-7.

Boucher, Georgie. “Transitory Ghosts and Angels in the Photography of Francesca Woodman.” *Traffic (Parkville)*, no. 9 (January 1, 2007): 89–105.

Brang, David, and V. S. Ramachandran. “Survival of the Synesthesia Gene: Why Do People Hear Colors and Taste Words?” *PLOS Biology* 9, no. 11 (November 22, 2011): e1001205. https://doi.org/10.1371/journal.pbio.1001205.

Brang, David, and Vilayanur S. Ramachandran. “How Do Crossmodal Correspondences and Multisensory Processes Relate to Synesthesia?” In *Multisensory Perception: From Laboratory to Clinic*, edited by K. Sathian and V. S. Ramachandran, 259–81. London: Academic Press, 2020. https://doi.org/10.1016/B978-0-12-812492-5.00012-7.

Braxton, Anthony. *Tri-Axium Writings , Anthony Braxton.* Vol. 1. San Francisco, CA: Synthesis Music, 1985.

Bremner, Andrew J., Serge Caparos, Jules Davidoff, Jan de Fockert, Karina J. Linnell, and Charles Spence. "'Bouba' and 'Kiki' in Namibia? A Remote Culture Make Similar Shape–Sound Matches, but Different Shape–Taste Matches to Westerners." *Cognition* 126, no. 2 (February 1, 2013): 165–72. https://doi.org/10.1016/j.cognition.2012.09.007.

Bröndum, Lars. "Graphic Notation, Indeterminacy and Improvisation: Implementing Choice Within a Compositional Framework." *Open Cultural Studies* 2, no. 1 (2018): 639–53. https://doi.org/10.1515/culture-2018-0058.

Brougher, Kerry. "Visual-Music Culture." In *Visual Music*, edited by Jane Hyun and Elizabeth Hamilton, 2005.

Bulusu, Vanalata, and Leslee Lazar. "Crossmodal Associations between Naturally Occurring Tactile and Sound Textures." *Perception* 53, no. 4 (April 1, 2024): 219–39. https://doi.org/10.1177/03010066231224557.

Cage, John. *Fontana Mix*. New York: Henmar Press/C.F. Peters, 1960.

———. *Silence : Lectures and Writings*. Wesleyan University Press, 1961.

Cambell, Murray. "Resonance." Grove Music Online. Accessed July 31, 2024. https://www.oxfordmusiconline.com/grovemusic/display/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000023236.

Cardew, Cornelius. *Treatise Handbook: Including Bun No. 2 [and] Volo Solo , Cornelius Cardew.* Edition Peters ; Nr. 07129. London ; Edition Peters, 1971.

Chan, San To, and Eliot Fried. "Marangoni Spreading on Liquid Substrates in New Media Art." Edited by Gary Grest. *PNAS Nexus* 3, no. 2 (February 1, 2024): pgae059. https://doi.org/10.1093/pnasnexus/pgae059.

Chen, Yi-Chuan, Pi-Chun Huang, Andy Woods, and Charles Spence. "When 'Bouba' Equals 'Kiki': Cultural Commonalities and Cultural Differences in Sound-Shape Correspondences." *Scientific Reports* 6, no. 1 (May 27, 2016): 26681. https://doi.org/10.1038/srep26681.

Ciecko, Anne. "Mary Hallock-Greenewalt's Spectral Middle East: Autobiographical Orientations and Reflexive Mediations." *Feminist Media Histories* 3, no. 1 (2017): 25–49. https://doi.org/10.1525/fmh.2017.3.1.25.

Cline, David. "Treatise and the Tractatus." *Journal of the Royal Musical Association* 145, no. 1 (May 2020): 119–66. https://doi.org/10.1017/rma.2020.5.

Cohen, Jonathan. "Synesthetic Perception as Continuous with Ordinary Perception, or: We're All Synesthetes Now." In *Sensory Blending: On Synaesthesia and Related Phenomena*,

edited by Ophelia Deroy, 0. Oxford University Press, 2017. https://doi.org/10.1093/oso/9780199688289.003.0004.

Collier, William G., and Timothy L. Hubbard. "Judgments of Happiness, Brightness, Speed and Tempo Change of Auditory Stimuli Varying in Pitch and Tempo." *Psychomusicology: A Journal of Research in Music Cognition* 17, no. 1–2 (2001): 36–55. https://doi.org/10.1037/h0094060.

Cook, Nicholas. *Analysing Musical Multimedia*. Oxford University Press., Inc, 1998.

Cooke, Grayson. "Improvisation in Live Audio-Visual Performance." *Screen Sound Journal*, 2011, 9–26.

Coward, Sean W., and Catherine J. Stevens. "Extracting Meaning from Sound: Nomic Mappings, Everyday Listening, and Perceiving Object Size from Frequency." *The Psychological Record* 54, no. 3 (July 1, 2004): 349–64. https://doi.org/10.1007/BF03395478.

Craig, Blanche. *Collage: Assembling Contemporary Art*. Edited by Blanche Craig. London: Black Dog Publishing, 2008.

Crenshaw, Kimberle. "Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics." *University of Chicago Legal Forum* 1989, no. 1 (December 7, 2015). https://chicagounbound.uchicago.edu/uclf/vol1989/iss1/8.

Crisinel, Anne-sylvie, and Charles spence. "As Bitter as a Trombone: Synesthetic Correspondences in Nonsynesthetes between Tastes/Flavors and Musical Notes." *Attention, Perception, & Psychophysics* 72, no. 7 (October 1, 2010): 1994–2002. https://doi.org/10.3758/APP.72.7.1994.

Curwen, Caroline. "Music-Colour Synaesthesia: Concept, Context and Qualia." *Consciousness and Cognition* 61 (May 2018): 94–106. https://doi.org/10.1016/j.concog.2018.04.005.

———. "The Role of Synaesthesia in Reading Written Musical Key Signatures." *Journal of Experimental Psychology: General* 151, no. 10 (2022): 2284–99. https://doi.org/10.1037/xge0001193.

Ćwiek, Aleksandra, Susanne Fuchs, Christoph Draxler, Eva Liina Asu, Dan Dediu, Katri Hiovain, Shigeto Kawahara, et al. "The *Bouba/Kiki* Effect Is Robust across Cultures and Writing Systems." *Philosophical Transactions of the Royal Society B: Biological Sciences* 377, no. 1841 (January 3, 2022): 20200390. https://doi.org/10.1098/rstb.2020.0390.

Cytowic, Richard E., David M. Eagleman, and Dmitri Nabokov. *Wednesday Is Indigo Blue: Discovering the Brain of Synesthesia*. Cambridge, UNITED STATES: MIT Press, 2009. http://ebookcentral.proquest.com/lib/ucsd/detail.action?docID=3338997.

Dennis, Brian. "Cardew's 'Treatise' (Mainly the Visual Aspects)." *Tempo*, no. 177 (June 1991): 10–16. https://doi.org/10.1017/S0040298200013516.

Deroy, Ophelia. "Introduction." In *Sensory Blending: On Synaesthesia and Related Phenomena*, edited by Ophelia Deroy, 0. Oxford University Press, 2017. https://doi.org/10.1093/oso/9780199688289.003.0001.

Deroy, Ophelia, Anne-Sylvie Crisinel, and Charles Spence. "Crossmodal Correspondences between Odors and Contingent Features: Odors, Musical Notes, and Geometrical Shapes." *Psychonomic Bulletin & Review* 20, no. 5 (October 2013): 878–96. https://doi.org/10.3758/s13423-013-0397-0.

Deroy, Ophelia, and Charles Spence. "Lessons of Synaesthesia for Consciousness: Learning from the Exception, Rather than the General." *Neuropsychologia*, Special Issue: Synaesthesia and Multisensory Processes, 88 (July 29, 2016): 49–57. https://doi.org/10.1016/j.neuropsychologia.2015.08.005.

———. "Why We Are Not All Synesthetes (Not Even Weakly So)." *Psychonomic Bulletin & Review* 20, no. 4 (August 1, 2013): 643–64. https://doi.org/10.3758/s13423-013-0387-2.

Dick, Robert. *The other flute: a performance manual of contemporary techniques , Robert Dick.* 2nd ed. New York: Multiple Breath Music Co., 1989.

Dolscheid, Sarah, Simge Çelik, Hasan Erkan, Aylin Küntay, and Asifa Majid. "Space-Pitch Associations Differ in Their Susceptibility to Language." *Cognition* 196 (March 1, 2020): 104073. https://doi.org/10.1016/j.cognition.2019.104073.

Donahue, Dustin. "Variations: Four Studies in the Aesthetics, History, and Performance of Indeterminate Music." UC San Diego, 2016. https://escholarship.org/uc/item/03m2f2kn.

Doty, David B. *The Just Intonation Primer : An Introduction to the Theory and Practice of Just Intonation*. 2nd ed. San Francisco, CA: Just intonation Network, 1994.

Dow, Arthur Wesley. *Composition: A Series of Exercies in Art Structure for the Use of Students and Teachers*. Garden City, NY: Double Day, Duran and company Inc., 1913.

Dudycha, George J., and Martha M. Dudycha. "A Case of Synesthesia: Visual Pain and Visual Audition." *The Journal of Abnormal and Social Psychology* 30, no. 1 (April 1935): 57–69. https://doi.org/10.1037/h0060678.

Eagleman, David M., and Melvyn A. Goodale. “Why Color Synesthesia Involves More than Color.” *Trends in Cognitive Sciences* 13, no. 7 (July 1, 2009): 288–92. https://doi.org/10.1016/j.tics.2009.03.009.

Eitan, Zohar. “Musical Connections: Cross-Modal Correspondences.” In *The Routledge Companion to Music Cognition*. Routledge, 2017.

Evans, Brian. “Foundations of a Visual Music.” *Computer Music Journal* 29, no. 4 (2005): 11–24.

Evans, K. K., and A. Treisman. “Natural Cross-Modal Mappings between Visual and Auditory Features.” *Journal of Vision* 10, no. 1 (January 6, 2011): 6–6. https://doi.org/10.1167/10.1.6.

Feisst, Sabine M. “John Cage and Improvisation: An Unresolved Relationship.” In *Musical Improvisation: Art, Education, and Society , Edited by Gabriel Solis and Bruno Nettl.*, edited by Gabriel Solis and Bruno Nettl. Urbana: University of Illinois Press, 2009.

“Fischinger. Sounding Ornaments.” Accessed August 7, 2024. https://asmir.info/lib/fischinger.htm.

Friedman, Ken. “The Early Days of Mail Art,” n.d.

Gabrielsson, Alf. “Strong Experiences with Music.” In *Handbook of Music and Emotion: Theory, Research, Applications*, edited by Patrik N. Juslin and John A. Sloboda, 547–74. Oxford University Press, 2010. https://doi.org/10.1093/acprof:oso/9780199230143.001.0001.

Gallace, Alberto, and Charles Spence. “Multisensory Synesthetic Interactions in the Speeded Classification of Visual Size.” *Perception & Psychophysics* 68, no. 7 (October 1, 2006): 1191–1203. https://doi.org/10.3758/BF03193720.

Gangadharan, Seeta Peña. “Mail Art: Networking without Technology.” *New Media & Society* 11, no. 1–2 (February 2009): 279–98. https://doi.org/10.1177/1461444808099581.

Gann, Kyle. *Arithmetic of Listening: Tuning Theory and History for the Impractical Musician.* University of Illinois Press, 2019.

Gawboy, Anna M., and Justin Townsend. “Scriabin and the Possible.” *Music Theory Online* 18, no. 2 (June 2012). https://doi.org/10.30535/mto.18.2.2.

Gelinas, John P. “It Happened in 1966: Andy Warhol’s Plastic Exploding Inevitable.” Accessed August 8, 2024. https://msmokemusic.com/blogs/mind-smoke-blog/posts/6563673/1966-any-warhol-s-plastic-exploding-inevitable.

Gilbert, Zanna. “The Untold Story of Xerox Art and Its Bold Female Pioneers | Getty News.” Getty, April 13, 2023. https://www.getty.edu/news/the-untold-story-of-xerox-art-and-its-bold-female-pioneers/.

Goehr, Lydia. *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music , Lydia Goehr.* Oxford [England: Clarendon Press, 1992.

Good, Jennifer. “The Impossible Photograph: Blur and Domestic Violence.” *Photography and Culture* 12, no. 4 (October 2, 2019): 415–27. https://doi.org/10.1080/17514517.2019.1665326.

Greenewalt, Mary Elizabeth Hallock-. *Nourathar, the Fine Art of Light Color Playing, by Mary Hallock Greenewalt*. Pennsylvania: Westbrook publishing company, 1946. https://hdl.handle.net/2027/mdp.39015022207529.

Guttman, Sharon E., Lee A. Gilroy, and Randolph Blake. “Hearing What the Eyes See: Auditory Encoding of Visual Temporal Sequences.” *Psychological Science* 16, no. 3 (March 1, 2005): 228–35. https://doi.org/10.1111/j.0956-7976.2005.00808.x.

Handmade Cinema. “Boyle Family.” Accessed August 8, 2024. https://handmadecinema.com/filmmaker/boyle-family/.

Harren, Natilee. “The Diagram Dematerialized, from Marcel Duchamp to John Cage to George Brecht.” *Athanor* 26 (2008): 99–105.

Hutton, Jo. “Daphne Oram: Innovator, Writer and Composer.” *Organised Sound* 8, no. 1 (April 2003): 49–56. https://doi.org/10.1017/S1355771803001055.

———. “Radiophonic Ladies,” Sonic Arts Network, 2000.

Imschloss, Monika, and Christina Kuehnl. “Feel the Music! Exploring the Cross-Modal Correspondence between Music and Haptic Perceptions of Softness.” *Journal of Retailing*, Sensory Aspects of Retailing, 95, no. 4 (December 1, 2019): 158–69. https://doi.org/10.1016/j.jretai.2019.10.004.

in^set. “About.” Accessed July 31, 2024. https://www.insettrio.com/about.

Isaacson, Atara, Amichay Assis, and Esther Adi-Japha. “‘Listening’ to Paintings: Synergetic Effect of a Cross-Modal Experience on Subjective Perception.” *Empirical Studies of the Arts* 41, no. 2 (July 2023): 433–64. https://doi.org/10.1177/02762374231155742.

James, David E. “Light Shows and Multimedia Shows.” In *See This Sound: Audiovisuology Compendium*, edited by Dieter Daniels, Sandra Naumann, and Jan Thoben, 177–85, 2010.

James, Richard S. “Avant-Garde Sound-on-Film Techniques and Their Relationship to Electro-Acoustic Music.” *The Musical Quarterly* 72, no. 1 (1986): 74–89.

Jensen, Hans Jørgen, Minna Rose Chung, and Grigory Kalinovsky. *ViolinMind:Intonation and Technique*. Ovation Press, Ltd., 2019.

Kanaya, Shoko, Kenji Kariya, and Waka Fujisaki. “Cross-Modal Correspondence Among Vision, Audition, and Touch in Natural Objects: An Investigation of the Perceptual Properties of Wood.” *Perception* 45, no. 10 (October 1, 2016): 1099–1114. https://doi.org/10.1177/0301006616652018.

Kandinsky, Wassily. *Concerning the Spiritual in Art*. Translated by Michael Sadleir. New York: Dover Publications, 1977.

Kaykov, Michael. “Scriabin’s Synesthesia, Demystified.” *ICONI*, The Manhattan School of Music, no. 3 (2021): 22–28. https://doi.org/10.33779/2658-4824.2021.3.022-028.

Kirkpatrick, Diane. “Sonia Landy Sheridan.” *Woman’s Art Journal* 1, no. 1 (1980): 56–59. https://doi.org/10.2307/1358020.

Klee, Paul. *Paul Klee: The Thinking Eye; the Notebooks of Paul Klee*. Edited by Jürg Spiller. New York: George Wittenborn, 1961.

Knowles, Alison. “Event Scores.” aknowles.com. Accessed July 27, 2024. https://www.aknowles.com/eventscore.html#.

Köhler, Wolfgang. *Gestalt Psychology*. Liveright. New York, 1929.

Küssner, Mats B., Dan Tidhar, Helen M. Prior, and Daniel Leech-Wilkinson. “Musicians Are More Consistent: Gestural Cross-Modal Mappings of Pitch, Loudness and Tempo in Real-Time.” *Frontiers in Psychology* 5 (July 28, 2014). https://doi.org/10.3389/fpsyg.2014.00789.

Leeuwen, Tessa M. van, Karl Magnus Petersson, and Peter Hagoort. “Synaesthetic Colour in the Brain: Beyond Colour Areas. A Functional Magnetic Resonance Imaging Study of Synaesthetes and Matched Controls.” *PLOS ONE* 5, no. 8 (August 10, 2010): e12074. https://doi.org/10.1371/journal.pone.0012074.

Levin, Gail. *Synchromism and American Color Abstraction, 1910-1925*. G. Braziller. New York, 1978.

Levitan, Carmel A, Sara A Charney, Karen B Schloss, and Stephen E Palmer. “The Smell of Jazz: Crossmodal Correspondences Between Music, Odor, and Emotion.” *CogSci* 1 (2015): 1326–31.

Lewis, George E. “Improvised Music after 1950: Afrological and Eurological Perspectives.” *Black Music Research Journal* 16, no. 1 (1996): 91–122. https://doi.org/10.2307/779379.

Lewkowicz, David J, Gerald Turkewitz, and Hunter College. “Cross-Modal Equivalence in Early Infancy: Auditory-Visual Intensity Matching.” *Developmental Psychology* 16, no. 6 (1980): 597–607.

Lindborg, PerMagnus, and Anders K. Friberg. “Colour Association with Music Is Mediated by Emotion: Evidence from an Experiment Using a CIE Lab Interface and Interviews.” *PloS One* 10, no. 12 (2015): e0144013. https://doi.org/10.1371/journal.pone.0144013.

Liu, Jianli, Edwin Lughofer, and Xianyi Zeng. “Aesthetic Perception of Visual Textures: A Holistic Exploration Using Texture Analysis, Psychological Experiment, and Perception Modeling.” *Frontiers in Computational Neuroscience* 9 (November 4, 2015). https://doi.org/10.3389/fncom.2015.00134.

“Lomography.” Accessed July 22, 2024. https://www.lomography.com/about.

Maeda, Fumiko, Ryota Kanai, and Shinsuke Shimojo. “Changing Pitch Induced Visual Motion Illusion.” *Current Biology* 14, no. 23 (December 2004): R990–91. https://doi.org/10.1016/j.cub.2004.11.018.

Manning, Peter. “The Oramics Machine: From Vision to Reality.” *Organised Sound* 17, no. 2 (August 2012): 137–47. https://doi.org/10.1017/S1355771812000064.

Marangoni Spreading on Liquid Substrates in New Media Art, 2024. https://www.youtube.com/watch?v=r_7unYKX_zc.

Marks, L. E. “On Cross-Modal Similarity: The Perceptual Structure of Pitch, Loudness, and Brightness.” *Journal of Experimental Psychology. Human Perception and Performance* 15, no. 3 (August 1989): 586–602. https://doi.org/10.1037//0096-1523.15.3.586.

Marks, Lawrence E. “Cross-Modal Interactions in Speeded Classification.” In *The Handbook of Multisensory Processes*, edited by Gemma A. Calvert, Charles Spence, and Barry E. Stein, 85–106. The MIT Press, 2004. https://doi.org/10.7551/mitpress/3422.003.0009.

———. “On Cross-Modal Similarity: Auditory–Visual Interactions in Speeded Discrimination.” *Journal of Experimental Psychology: Human Perception and Performance* 13, no. 3 (August 1987): 384–94. https://doi.org/10.1037/0096-1523.13.3.384.

———. “Synesthesia, Then and Now.” In *Sensory Blending: On Synaesthesia and Related Phenomena*, edited by Ophelia Deroy, 0. Oxford University Press, 2017. https://doi.org/10.1093/oso/9780199688289.003.0002.

Marks, Lawrence E., Robin J. Hammeal, Marc H. Bornstein, and Linda B. Smith. “Perceiving Similarity and Comprehending Metaphor.” *Monographs of the Society for Research in Child Development* 52, no. 1 (1987): i–100. https://doi.org/10.2307/1166084.

Marks, Lawrence E., and Catherine M. Mulvenna. “Synesthesia, at and near Its Borders.” *Frontiers in Psychology* 4 (September 26, 2013). https://doi.org/10.3389/fpsyg.2013.00651.

Marks, Lawrence E, Rosemary Szczesiul, and Patricia Ohlott. “On the Cross-Modal Perception of Intensity.” *Journal of Experimental Psychology; Human Perception and Performance* 12, no. 4 (1986): 517–34.

Matlaw, Ralph E. “Scriabin and Russian Symbolism.” *Comparative Literature* 31, no. 1 (1979): 1. https://doi.org/10.2307/1770938.

Mills, Carol Bergfeld, Edith Howell Boteler, and Glenda K Larcombe. “‘Seeing Things in My Head’: A Synesthete’s Images for Music and Notes.” *Perception* 32, no. 11 (November 1, 2003): 1359–76. https://doi.org/10.1068/p5100.

Morgan, Ann Lee. “Pictorialism.” In *The Oxford Dictionary of American Art and Artists*. Oxford University Press, 2018. https://www.oxfordreference.com/display/10.1093/acref/9780191807671.001.0001/acref-9780191807671-e-1051.

Moritz, William. “The Dream of Color Music, And Machines That Made It Possible.” *Animation World Magazine*, no. 2.1 (April 1997). https://www.awn.com/mag/issue2.1/articles/moritz2.1.html.

———. “Towards an Aesthetic of Visual Music,” 1986. http://www.centerforvisualmusic.org/TAVM.htm.

Motoki, Kosuke, Lawrence E. Marks, and Carlos Velasco. “Reflections on Cross-Modal Correspondences: Current Understanding and Issues for Future Research.” *Multisensory Research* 37, no. 1 (November 10, 2023): 1–23. https://doi.org/10.1163/22134808-bja10114.

Myers, C. S. “Two Cases of Synaesthesia.” *British Journal of Psychology* 7, no. 1 (May 1, 1914): 112–17.

Nakayama Akiko. “Alive Painting video.” website. Accessed August 8, 2024. https://www.akikopainting.com/video.

———. “Statement.” website. Accessed August 12, 2024. https://www.akikopainting.com/statement.

O'Callaghan, Casey. "Synesthesia vs. Crossmodal Illusions." In *Sensory Blending: On Synaesthesia and Related Phenomena*, edited by Ophelia Deroy, 0. Oxford University Press, 2017. https://doi.org/10.1093/oso/9780199688289.003.0003.

Ohtake, Yuka, Kanji Tanaka, and Kentaro Yamamoto. "How Many Categories Are There in Crossmodal Correspondences? A Study Based on Exploratory Factor Analysis." *PLOS ONE* 18, no. 11 (November 14, 2023): e0294141. https://doi.org/10.1371/journal.pone.0294141.

O'Keeffe, Georgia. *Georgia O'Keeffe.* A Studio Book. New York: Viking Press, 1976.

Okinawa Institute of Science and Technology OIST. "Beyond the Ink: Painting with Physics," February 29, 2024. https://www.oist.jp/news-center/news/2024/2/29/beyond-ink-painting-physics.

Onibere, Victor. "Evolution of Collage as a Medium and Its Influence on Modern Art," 1–5, 2024.

Paisa, Razvan, Niels Christian Nilsson, and Stefania Serafin. "Tactile Displays for Auditory Augmentation–A Scoping Review and Reflections on Music Applications for Hearing Impaired Users." *Frontiers in Computer Science* 5 (April 27, 2023). https://doi.org/10.3389/fcomp.2023.1085539.

Palmer, Stephen E., Karen B. Schloss, Zoe Xu, and Lilia R. Prado-León. "Music–Color Associations Are Mediated by Emotion." *Proceedings of the National Academy of Sciences* 110, no. 22 (May 28, 2013): 8836–41. https://doi.org/10.1073/pnas.1212562110.

Parise, Cesare V., Katharina Knorre, and Marc O. Ernst. "Natural Auditory Scene Statistics Shapes Human Spatial Hearing." *Proceedings of the National Academy of Sciences* 111, no. 16 (April 22, 2014): 6104–8. https://doi.org/10.1073/pnas.1322705111.

Pavlovsky, Steve. "Liquid Light Lab." Accessed August 2, 2024. https://liquidlightlab.com/home.html.

Peacock, Kenneth. "Instruments to Perform Color-Music: Two Centuries of Technological Experimentation." *Leonardo* 21, no. 4 (1988): 397. https://doi.org/10.2307/1578702.

Pereira, M., T. De Lacerda-Arôso, M.J.M. Gomes, A. Mata, L.C. Alves, and Philippe Colomban. "Ancient Portuguese Ceramic Wall Tiles ('Azulejos'): Characterization of the Glaze and Ceramic Pigments." *Journal of Nano Research* 8 (September 2009): 79–88. https://doi.org/10.4028/www.scientific.net/JNanoR.8.79.

Pitteri, Marco, Mauro Marchetti, Konstantinos Priftis, and Massimo Grassi. "Naturally Together: Pitch-Height and Brightness as Coupled Factors for Eliciting the SMARC Effect in Non-Musicians." *Psychological Research* 81, no. 1 (January 1, 2017): 243–54. https://doi.org/10.1007/s00426-015-0713-6.

"pOoTers pSycheDelic shAcK - The Rabbit Hole." Accessed July 24, 2024. https://www.pooterland.com/lightshow_rabbit_hole.html.

Pritchett, James. *The Music of John Cage. Cambridge*. Cambridge, England: Cambridge University Press, 1993.

"Q and Art: Stanton Macdonald-Wright and His Kinetic Art Machine | Smithsonian American Art Museum." Accessed August 5, 2024. https://americanart.si.edu/blog/eye-level/2014/22/526/q-and-art-stanton-macdonald-wright-and-his-kinetic-art-machine.

Ramachandran, V S, and E M Hubbard. "Synaesthesia — A Window Into Perception, Thought and Language." *Journal of Consciousness Studies* 8, no. 12 (2001): 3–34.

Ramachandran, Vilayanur S., and Edward M. Hubbard. "Hearing Colors, Tasting Shapes." *Scientific American* 288, no. 5 (2003): 52–59.

"Rheostat | Resistor Types | Resistor Guide." Accessed August 6, 2024. https://eepower.com/resistor-guide/resistor-types/rheostat/.

Rich, A. N., J. L. Bradshaw, and J. B. Mattingley. "A Systematic, Large-Scale Study of Synaesthesia: Implications for the Role of Early Experience in Lexical-Colour Associations." *Cognition* 98, no. 1 (November 1, 2005): 53–84. https://doi.org/10.1016/j.cognition.2004.11.003.

Rimington, A. Wallace. *Colour Music : The Art of Mobile Colour*. London: Hutchinson & Co, 1912.

Robinson, Julia. "From Abstraction to Model: George Brecht's Events and the Conceptual Turn in Art of the 1960s." *October* 127 (2009): 77–108.

Rusconi, Elena, Bonnie Kwan, Bruno L. Giordano, Carlo Umiltà, and Brian Butterworth. "Spatial Representation of Pitch Height: The SMARC Effect." *Cognition* 99, no. 2 (March 1, 2006): 113–29. https://doi.org/10.1016/j.cognition.2005.01.004.

Russo, Frank, Paolo Ammirante, and Deborah Fels. "Vibrotactile Discrimination of Musical Timbre." *Journal of Experimental Psychology. Human Perception and Performance* 38 (June 18, 2012): 822–26. https://doi.org/10.1037/a0029046.

Sapir, E. "A Study in Phonetic Symbolism." *Journal of Experimental Psychology* 12, no. 3 (June 1929): 225–39. https://doi.org/10.1037/h0070931.

"Scanography - Introduction :: LaserSoft Imaging." Accessed August 3, 2024. https://www.silverfast.com/show/application-scanography/en.html.

Schröder, Julia H. “Graphic Notation and Musical Graphics: Between Music Notation and Visual Art.” In *See This Sound: Audiovisuology Compendium: An Interdisciplinary Survey of Audiovisual Culture*, 150–61. Köln: Ludwig Boltzmann Institute, 2010.

“Schubert.Ferrofluids.Pdf.” Accessed August 8, 2024. https://ncmn.unl.edu/outreach/images2/Schubert.Ferrofluids.pdf.

Schwierin, Marcel, and Naumann Sandra. “The Musicality of Abstract Film.” In *See This Sound:Audiovisuology Compendium*, edited by Dieter Daniels, Sandra Naumann, and Jan Thoben, 19–31. Ludwig Boltzmann Institute, 2010.

Scott, S.K. “Speech Perception: Cortical Processing.” In *Encyclopedia of Neuroscience*, 227–31. Elsevier, 2009. https://doi.org/10.1016/B978-008045046-9.01901-X.

Sevsay, Ertuğrul. *The Cambridge Guide to Orchestration*. New York, UNITED STATES: Cambridge University Press, 2013. http://ebookcentral.proquest.com/lib/ucsd/detail.action?docID=1182955.

Shayan, Shakila, Ozge Ozturk, and Mark A. Sicoli. “The Thickness of Pitch: Crossmodal Metaphors in Farsi, Turkish, and Zapotec.” *The Senses and Society* 6, no. 1 (March 1, 2011): 96–105. https://doi.org/10.2752/174589311X12893982233911.

Sidhu, David M., and Penny M. Pexman. “Five Mechanisms of Sound Symbolic Association.” *Psychonomic Bulletin & Review* 25, no. 5 (October 1, 2018): 1619–43. https://doi.org/10.3758/s13423-017-1361-1.

Siedenburg, Kai, Michel Bürgel, Elif Özgür, Christoph Scheicht, and Stephan Töpken. “Vibrotactile Enhancement of Musical Engagement.” *Scientific Reports* 14, no. 1 (April 2, 2024): 7764. https://doi.org/10.1038/s41598-024-57961-8.

Sievers, Beau, Larry Polansky, Michael Casey, and Thalia Wheatley. “Music and Movement Share a Dynamic Structure That Supports Universal Expressions of Emotion.” *Proceedings of the National Academy of Sciences* 110, no. 1 (January 2, 2013): 70–75. https://doi.org/10.1073/pnas.1209023110.

Simner, Julia, and Emma Holenstein. “Ordinal Linguistic Personification as a Variant of Synesthesia.” *Journal of Cognitive Neuroscience* 19, no. 4 (April 1, 2007): 694–703. https://doi.org/10.1162/jocn.2007.19.4.694.

Simner, Julia, Catherine Mulvenna, Noam Sagiv, Elias Tsakanikos, Sarah A Witherby, Christine Fraser, Kirsten Scott, and Jamie Ward. “Synaesthesia: The Prevalence of Atypical Cross-Modal Experiences.” *Perception* 35, no. 8 (August 2006): 1024–33. https://doi.org/10.1068/p5469.

Simner, Julia, Jamie Ward, Monika Lanz, Ashok Jansari, Krist Noonan, Louise Glover, and David A. Oakley. “Non-Random Associations of Graphemes to Colours in Synaesthetic

and Non-Synaesthetic Populations." *Cognitive Neuropsychology* 22, no. 8 (December 2005): 1069–85. https://doi.org/10.1080/02643290500200122.

Simon, Jane, and Mio Bryce. "The Labour of Light: Gender, Technology and the Domestic in the Photography of Nagashima Yurie and Kawauchi Rinko." *Women's History Review* 31, no. 4 (June 7, 2022): 645–70. https://doi.org/10.1080/09612025.2021.1944351.

Small, Christopher. *Music of the Common Tongue:Survival and Celebration in African American Music*. Hanover, NH: Wesleyan University, 1998.

Smilek, Daniel, Kelly A. Malcolmson, Jonathan S. A. Carriere, Meghan Eller, Donna Kwan, and Michael Reynolds. "When '3' Is a Jerk and 'E' Is a King: Personifying Inanimate Objects in Synesthesia." *Journal of Cognitive Neuroscience* 19, no. 6 (June 1, 2007): 981–92. https://doi.org/10.1162/jocn.2007.19.6.981.

Smith, Linda B, and Maria D Sera. "A Developmental Analysis of the Polar Structure of Dimensions." *Cognitive Psychology* 24, no. 1 (January 1992): 99–142. https://doi.org/10.1016/0010-0285(92)90004-L.

Smith, Shawn Michelle. *At the Edge of Sight: Photography and the Unseen.* New York, NY, USA: Duke University Press, 2013.

Soto-Faraco, Salvador, Charles Spence, and Alan Kingstone. "Cross-Modal Dynamic Capture: Congruency Effects in the Perception of Motion Across Sensory Modalities." *Journal of Experimental Psychology: Human Perception and Performance* 30, no. 2 (2004): 330–45. https://doi.org/10.1037/0096-1523.30.2.330.

Spence, Charles. "Assessing the Role of Emotional Mediation in Explaining Crossmodal Correspondences Involving Musical Stimuli." *Multisensory Research* 33, no. 1 (July 1, 2020): 1–29. https://doi.org/10.1163/22134808-20191469.

———. "Crossmodal Correspondences: A Tutorial Review." *Attention, Perception, & Psychophysics* 73, no. 4 (2011): 971–95. https://doi.org/10.3758/s13414-010-0073-7.

———. "Exploring Group Differences in the Crossmodal Correspondences." *Multisensory Research* 35, no. 6 (August 9, 2022): 495–536. https://doi.org/10.1163/22134808-bja10079.

Spence, Charles, and Ophelia Deroy. "On the Shapes of Flavours: A Review of Four Hypotheses." *Theoria et Historia Scientiarum* 10 (May 7, 2014): 207. https://doi.org/10.12775/ths-2013-0011.

Spence, Charles, and Mary Kim Ngo. "Assessing the Shape Symbolism of the Taste, Flavour, and Texture of Foods and Beverages." *Flavour* 1, no. 1 (July 2, 2012): 12. https://doi.org/10.1186/2044-7248-1-12.

Spence, Charles, and K. Sathian. “Audiovisual Crossmodal Correspondences: Behavioral Consequences and Neural Underpinnings.” In *Multisensory Perception: From Labratory to Clinic*, edited by K. Sathian and V. S. Ramachandran, 239–58. Academic Press, 2020. https://doi.org/10.1016/B978-0-12-812492-5.00011-5.

Spence, Charles, and Massimiliano Zampini. “Auditory Contributions to Multisensory Product Perception.” *Acta Acustica United with Acustica* 92, no. 6 (November 1, 2006): 1009–25.

Spinrad, Paul. *The VJ Book: Inspirations and Practical Advice for Live Visuals Performance*. Los Angeles, CA: Feral House, 2005.

“Split-Tones - The Modern Trumpet by Nathan PlanteThe Modern Trumpet by Nathan Plante.” Accessed July 22, 2024. https://themoderntrumpet.com/2020/10/20/split-tones/.

Stekelenburg, Jeroen J., and Mirjam Keetels. “The Effect of Synesthetic Associations between the Visual and Auditory Modalities on the Colavita Effect.” *Experimental Brain Research* 234, no. 5 (May 2016): 1209–19. https://doi.org/10.1007/s00221-015-4363-0.

Stevens, S S. “ON THE PSYCHOPHYSICAL LAW.” *The Psychological Review* 64, no. 3 (1957).

Stiegler, Bernd. “1. Imperfection.” Fotomuseum Winterthur. Accessed July 20, 2024. https://www.fotomuseum.ch/en/2012/01/11/imperfection/.

Strange, Patricia, and Allen Strange. *The Contemporary Violin: Extended Performance Techniques , Patricia Strange and Allen Strange.* The New Instrumentation 7. Berkeley: University of California Press, 2001.

Strick, Jeremy. “Visual Music.” In *Visual Music: Synesthesia in Art and Music Since 1900 (Exhibition Catalog)*, edited by Jane Hyun and Elizabeth Hamilton, 15–20. New York: Thames & Hudson., 2005.

The University of Edinburgh. “What Is Microscopy?,” September 27, 2018. https://www.ed.ac.uk/clinical-sciences/edinburgh-imaging/for-patients-study-participants/tell-me-more-about-my-scan/what-is-microscopy.

Van Cleve, Libby. *Oboe Unbound: Contemporary Techniques*. Revised edition. Oboe Unbound. Blue Ridge Summit: Rowman & Littlefield Publishers, Incorporated, 2014.

Walker, Laura, Peter Walker, and Brian Francis. “A Common Scheme for Cross-Sensory Correspondences across Stimulus Domains.” *Perception* 41, no. 10 (October 1, 2012): 1186–92. https://doi.org/10.1068/p7149.

Walker, Peter. “Cross-Sensory Correspondences: A Theoretical Framework and Their Relevance to Music.” *Psychomusicology: Music, Mind, and Brain* 26, no. 2 (2016): 103–16. https://doi.org/10.1037/pmu0000130.

Walker, Peter, J. Gavin Bremner, Uschi Mason, Jo Spring, Karen Mattock, Alan Slater, and Scott P. Johnson. “Preverbal Infants’ Sensitivity to Synaesthetic Cross-Modality Correspondences.” *Psychological Science* 21, no. 1 (January 2010): 21–25. https://doi.org/10.1177/0956797609354734.

Walker, Robert. “The Effects of Culture, Environment, Age, and Musical Training on Choices of Visual Metaphors for Sound.” *Perception & Psychophysics* 42, no. 5 (September 1987): 491–502. https://doi.org/10.3758/BF03209757.

Wan, Xiaoang, Andy T. Woods, Jasper J. F. van den Bosch, Kirsten J. McKenzie, Carlos Velasco, and Charles Spence. “Cross-Cultural Differences in Crossmodal Correspondences between Basic Tastes and Visual Features.” *Frontiers in Psychology* 5 (December 8, 2014). https://doi.org/10.3389/fpsyg.2014.01365.

Wang, Qian (Janice), Andy T. Woods, and Charles Spence. “‘What’s Your Taste in Music?’ A Comparison of the Effectiveness of Various Soundscapes in Evoking Specific Tastes.” *I-Perception* 6, no. 6 (December 1, 2015): 2041669515622001. https://doi.org/10.1177/2041669515622001.

Waniuk, Ilana. “Artifact II.” Unpublished score, 2023.

———. “DMA Qualifying Exam. Question III.” University of California San Diego, 2021.

———. “Epistolary Transmissions.” Unpublished instructions, 2021.

Ward, Jamie, and Michael J Banissy. “Explaining Mirror-Touch Synesthesia.” *Cognitive Neuroscience* 6, no. 2–3 (July 3, 2015): 118–33. https://doi.org/10.1080/17588928.2015.1042444.

Ward, Jamie, and Julia Simner. “Synesthesia: The Current State of the Field.” In *Multisensory Perception*, edited by K. Sathian and V. S. Ramachandran, 283–300. Academic Press, 2020. https://doi.org/10.1016/B978-0-12-812492-5.00013-9.

Ward, Jamie, Elias Tsakanikos, and Alice Bray. “Synaesthesia for Reading and Playing Musical Notes.” *Neurocase* 12, no. 1 (February 2006): 27–34. https://doi.org/10.1080/13554790500473672.

Waterman, Alex, Debra Singer, and Matthew Lyons, eds. *Between Thought and Sound: Graphic Notation in Contemporary Music*. New York, NY: The Kitchen, 2007.

Watson, Marcus R., Kathleen Akins, Chris Spiker, Lyle Crawford, and James T. Enns. “Synesthesia and Learning: A Critical Review and Novel Theory.” *Frontiers in Human Neuroscience* 8 (February 28, 2014). https://doi.org/10.3389/fnhum.2014.00098.

Whistler, James McNeill. *The Gentle Art of Making Enemies, Ed. by Sheridan Ford.* New York: F. Stokes & Brother, 1890.

Whiteford, Kelly L., Karen B. Schloss, Nathaniel E. Helwig, and Stephen E. Palmer. "Color, Music, and Emotion: Bach to the Blues." *I-Perception* 9, no. 6 (November 1, 2018): 2041669518808535. https://doi.org/10.1177/2041669518808535.

Whitelaw, Mitchell. "Synesthesia and Cross-Modality in Contemporary Audiovisuals." *The Senses and Society* 3, no. 3 (November 2008): 259–76. https://doi.org/10.2752/174589308X331314.

Williams, Christopher. "Tactile Paths: On and through Notation for Improvisers." Phd diss, University of Leiden, 2016.

Wiseman, Ari. "Expanding the Synaesthetic Paradigm." In *Visual Music: Synesthesia in the Art and Music since 1900*, edited by Jane Hyun and Elizabeth Hamilton, 2005.

Youngblood, Gene. *Expanded Cinema*. E.P Dutton & Co., Inc., New York, 1970.

Yun, Gao, and Xia Jiali. "Research and Exploration on Cymatics in Sound Visualization." *E3S Web of Conferences* 486 (2024): 03002. https://doi.org/10.1051/e3sconf/202448603002.

Zilczer, Judith. "American Rhapsody: From Modern to Postmodern in Visual Music." In *The Oxford Handbook of Sound and Image in Western Art*, edited by Yael Kaduri, 0. Oxford University Press, 2016. https://doi.org/10.1093/oxfordhb/9780199841547.013.5.

———. "'Color Music': Synaesthesia and Nineteenth-Century Sources for Abstract Art." *Artibus et Historiae* 8, no. 16 (1987): 101–26. https://doi.org/10.2307/1483303.

———. "Music for the Eyes: Abstract Painting and Light Art." In *Visual Music: Synesthesia in Art and Music Since 1900 (Exhibition Catalog)*, edited by Jane Hyun and Elizabeth Hamilton, 25–87. New York: Thames & Hudson., 2005.

Zinman, Gregory. "JOSHUA LIGHT SHOW 1967-68," 2012. https://www.joshualightshow.com/about-classic/joshua-light-show-1967-68.