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The Entanglement of Art, Life, and Entrainment

A Dialogue Between Alva Noë and Nishida Kitarō

Thesis presented by

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for the degree of

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December, 2024

Declaration

I, David Walsh, hereby certify that this thesis is my own work and that it has not been previously submitted for another degree, either at this University College Cork or elsewhere.

_____

David Walsh

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Abstract:

This dissertation argues that art, life, and entrainment are entangled, and that this entanglement shapes what we are: an aesthetic phenomenon. This argument is developed through a novel dialogue between Alva Noë and Nishida Kitarō, whose theories, despite not being traditionally discussed together, recognise art as something that actively organises and is organised within the world. This dissertation presents three main theses: first, Nishida and Noë share a comparable understanding of art, and when placed in dialogue, their perspectives create a more robust theory. Second, Nishida and Noë's perspectives can be grounded in the phenomenon of entrainment—a process of emergent synchronisation that is spontaneously initiated and sustained by the transfer of energy between open energy systems—which provides a concrete mechanism for their theories of art. Finally, Nishida and Noë expand on the idea of entrainment in science, showing how entrainment in the material, biological, and, crucially, sociohistorical world shapes what we are. This dissertation reveals how the entanglement of art, life, and entrainment organises and gets organised within the world, offering novel insights about the reciprocity between artist and art, creator and created, and, more fundamentally, between mind and world.

Introduction and Overview

Introduction

You are not just an object. You are not merely a piece of meat. You are not just a brain. You are not merely a body. You are far more. You are active and embodied, situated within the material, biological, social, and historical world. Your actions and thoughts shape the world which, in turn, shapes your actions and thoughts. You are part of an ongoing creative activity that both includes and transcends your own. You are an aesthetic phenomenon. You are a work of art. You are *the* work of art.

1. Research Topic

For Nishida Kitarō 西田 幾多郎 and Alva Noë, art and life are deeply entangled, exemplifying how our actions and intuitions shape a world which, in turn, shapes our actions and intuitions. For both, the artist acts and is acted upon, organises and is organised, creates and is created, by a world that both includes and transcends their own actions and intuitions. Painting, dancing, music, literature, theatre, cinema, and even architecture—all are part of a continuous creative process that includes and transcends the activities of the individual artist. Art shapes the world which shapes art. In art, the artist and the world are mutually shaped.

Although rarely discussed together, Nishida and Noë share an implicitly enactivist understanding of art. Influenced by *Mahāyāna* महायान Buddhism, autopoietic enactivism, first articulated by Francisco Varela, Evan Thompson, and Eleanor Rosch, posits that cognition is 'the enactment of a world and a mind.'[1] Just as a flower sprouts from the mutual

[1] Francisco Varela, Evan Thompson, and Eleanor Rosch (1991). *The Embodied Mind: Cognitive Science and Human Experience.* Cambridge, Mass: MIT Press, p.9. See also Humberto R. Maturana, and Francisco J. Varela

relations of a seed, soil, water, and sunlight, cognition emerges from the mutual interactions of a brain, body, and world. Although Nishida is not typically associated with enactivism, his novel concept of "*kōiteki chokkan*" 行為的直観 (acting, or active intuition) is recognisably so, with John C. Maraldo conceptually translating it as 'enactive intuition.'[2] Therefore, given their connections and similar interests, Nishida and Noë are well positioned to discuss art and its place in our lives, challenging conventional distinctions between art and artist, creator and created, perceiver and perceived, and, more fundamentally, between mind and world.

Kōiteki chokkan is Nishida's response to criticisms of psychologism, most notably from Takahashi Satomi 高橋 里美[3] and Hajime Tanabe 田辺 元,[4] which claim that his chosen terminology, as Maraldo explains, 'would reduce logic to the contingencies of the individual mind or brain.'[5] While Nishida would later expand upon *kōiteki chokkan*, going beyond the confines of human psychology with his broader idea of "*basho*" 場所 (place), this concept can be understood as Nishida's attempt to clarify his position and chosen terminology, while also offering a more comprehensive understanding of '*a world in which that which is made makes that which makes*.'[6]

(1992). *The Tree of Knowledge: The Biological Roots of Human Understanding, Revised Edition.* Shambhala; and Evan Thompson (2010). *Mind in Life.* Cambridge, MA: Harvard University Press.

[2] John C. Maraldo (2017). *Japanese Philosophy in the Making 1: Crossing Paths with Nishida*. Nagoya, Japan; Chisokudō Publications. p.200.

[3] Ching-Yuen Cheung (2018). Nishida Kitarō, Takahashi Satomi and the Schelerian Philosophy of Love, In – Andrea Altobrando, Takuya Niikawa, and Richard Stone, eds. (2018). *The Realizations of the Self.* Springer; Palgrave Macmillan. Chapter 14.

[4] Hajime Tanabe (1986). *Philosophy as Metanoetics*. University of California Press. Chapters 2 and 3. While Tanabe deliberately refuses to refer to Nishida directly in his book, implicit in much of his work is a criticism of his former friend.

[5] John C. Maraldo (2019). Nishida Kitarō, *Stanford Encyclopedia of Philosophy Archive*. Second paragraph.

[6] Nishida Kitarō (1937). The Historical Body, In – David A. Dilworth, Valdo H. Viglielmo, and Agustin Jacinto Zavala, eds. & trans. (1998). *Sourcebook for Modern Japanese Philosophy: Selected documents*. United States: Greenwood Press. p.48.

For Nishida, *kōiteki chokkan* is pragmatically exemplified in the creation of art, what he often calls 'artistic intuition'[7] or 'aesthetic intuition.'[8] This is when the artist intuits the world around them, allowing what is and can be conceivably created to be shaped by their actions in relation to the world. Nishida explains: '[i]n artistic activity we neither structure things conceptually nor imitate things merely passively. Things beckon and move us.'[9] In other words, the world beckons us to create art, in the sense that art both shapes and is shaped by the world. Accordingly, for Nishida, we are all works of art, as art creates us as much as we create it.

Noë has a comparable understating of art. First articulated in *Strange Tools: Art and Human Nature*,[10] and later developed in *The Entanglement: How Art and Philosophy Make Us What We Are*,[11] Noë argues that '[o]ur lives are one big complex nesting of organized activities at different levels and scales. [...] We are always captured by structures of organization. This is our natural, indeed our biological, condition. It is the basic fact about us.'[12] These structures of organisation are the norms, practices, and values that bind us and shape who and what we are. They influence how we learn, how we communicate, and how we express ourselves. 'Talking, walking, eating, perceiving, driving,'[13] reading, writing, singing, dancing, fighting, and many more—all are examples, as will be shown, of how we both organise and get organised by our activities.

For Noë, art offers liberation from organised activities, as art is a creative activity whose 'preoccupation is with the ways we are organized and with the possibility of

[7] Kitarō Nishida, and David A. Dilworth, trans. (1970). *Nishida Kitaro's Fundamental Problems of Philosophy: The World of Action and The Dialectical World.* Tokyo: Sophia University. p.178.
[8] Nishida (1970). *Fundamental Problems of Philosophy*. p.173.
[9] Ibid. p.179.
[10] Ava Noë (2015). *Strange Tools: Art and Human Nature*. New York; Hill and Wang: A division of Farrar, Strauss and Giroux. p.167
[11] Alva Noë (2023) *The Entanglement: How art and philosophy make us what we are*. Princeton; Princeton University Press.
[12] Noë (2015). *Strange Tools.* p.10
[13] Ibid. p.10.

reorganizing ourselves.'[14] This is why Noë calls art a "strange tool." For Noë, art is strange because, by design, it appears odd at first, thereby offering us new and previously unrecognised ways of organisation. Art is also a tool, as it is something that we use to investigate, disrupt, and reorganise the organised activities that shape our lives.

However, as will be shown in Chapter 1, Section 6.2, when Noë describes art as a "strange tool," he does not do so in the sense of literal tool-making or tool-using—both of which Nishida will be shown to discuss at length—but rather as an activity that investigates and disrupts organised activities. Accordingly, for Noë, art is deeply embedded in our lives, to the extent that '[a]rt is not an add-on, a mere cultural extra, but a basic and central part of what makes culture possible.'[15] Art, for Noë, is the driving force behind culture and what we are, as art and life are entangled and 'we ourselves are products of this entanglement.'[16] Accordingly, like Nishida, Noë argues that we are all works of art, and that art creates us as much as we create it. Art makes us what we are: an aesthetic phenomenon.

While Nishida and Noë largely agree that art involves action and intuition, while also having the ability to shape the organised activities that shape our lives, they disagree on two points. Firstly, for Noë, art is the creation of a preexisting artist that then (and only then) works to reorganise life. In contrast, Nishida argues that both art and the artist are mutually created through the artistic activities. Secondly, for Nishida, art and science are both paradigm examples of *kōiteki chokkan* whereas, for Noë, art has more in common with philosophy than it does science. While acknowledging the link between art and science, Noë argues that science is a techne that is confined by the organised activities that art and philosophy aim to reshape.

[14] Noë (2015). *Strange Tools.* p.xiii
[15] Noë (2023). *The Entanglement.* p.3.
[16] Ibid. p.8.

These differences will become increasingly important as this dissertation explores art and its place in our lives. By comparing Nishida's concept of "*kōiteki chokkan*" and Noë's implicitly enactivist understanding, this dissertation examines how artistic activities and intuitions both organise and get organised by the world, highlighting the reciprocity between art and artist, creator and created, perceiver and perceived, and, more fundamentally, between mind and world.

2. Research Problem

The problem with Nishida and Noë's understanding of art is twofold. On one hand, both explain how art shapes the individual, but do not describe the underlying mechanisms by which the individual shapes art. On the other hand, both explain how the individual shapes art, but do not describe the underlying mechanisms by which art shapes the individual. While their perspectives are comparable, as we will see, Nishida and Noë's philosophies lack a concrete explanation of how artistic activities both organise and get organised by the world.

While this dissertation strongly endorses Nishida and Noë's understanding of art, this problem highlights the need for a concrete mechanism that accounts for how artistic actions and intuitions shape the world which, in turn, shapes artistic actions and intuitions. To address this, the phenomenon of entrainment is offered a concrete mechanism for this interaction, providing an explanation for how the individual shapes art and how art shapes the individual.

Entrainment is a fundamental and pervasive phenomenon that shapes and organises much of our reality. Identified in fields such as physics, biology, neuroscience, and social interactions, and paradigmatically exemplified in art, entrainment is defined by Thaut et al. as 'a temporal locking process in which one system's motion or signal frequency entrains the

frequency of another system.'[17] Entrainment spontaneously emerges when an Energy Transfer Mechanism (ETM) shared between open systems initiates and sustains a period of emergent synchronisation, thereby allowing the systems to entrain. In the context of entrainment, "spontaneous" means that synchronisation emerges naturally from systems' inherent interactions, without external intervention. In short, entrainment offers brief moments of organisation in an increasingly disorganised universe. Extending into the worlds of *kōiteki chokkan* and of organised activities, entrainment is a mechanism that explains how actions and intuitions organise the world which, in turn, organises actions and intuitions. By combining Nishida and Noë's philosophies, and grounding both in the phenomenon of entrainment, this dissertation offers a more comprehensive and empirical understanding of the entanglement of art, life, and entrainment, as well as how this entanglement shapes what we are.

3. Conceptual Foundations

3.1 Enactivism

This dissertation is not about enactivism or embodied/enacted cognition, at least, not directly. It is about art, specifically about how creative activities shape and organise the world which, in turn, shapes and organises creative activities, and how this exchange makes us what we are. Since Varela et al. first described their idea of "autopoietic enactivism" in *The Embodied Mind: Cognitive Science and Human Experience*,[18] enactivist theory has attracted attention from thinkers across various disciplines, both within and beyond philosophy and cognitive science. Sensorimotor enactivism, advocated by Alva Noë and Kevin O'Regan, suggests that '*vision is a mode of exploration of the world that is mediated by knowledge of*

[17] Michael H. Thaut, Gerald C. McIntosh, and Volker Hoemberg (2015). Neurobiological Foundations of Neurologic Music Therapy: Rhythmic Entrainment and the Motor System, *Frontiers in Psychology*. 5(1185), p.1.
[18] Varela et al. (1991). *The Embodied Mind.*

what we call sensorimotor contingencies,'[19] and that the perceived world 'serves as its own, external, representation.'[20] This highlights how our interactions with and within the world influence our perceptual experiences. Similar to Noë and O'Regan, in *Geijutsu to Dōtoku* 芸術と道徳 (*Art and Morality*), Nishida posits that '[t]his world can be seen only through expressive movement,'[21] arguing that seeing and acting are intrinsically linked. *Kōiteki chokkan*, as we saw, resonates with enactivist theories, as Maraldo explains that, for Nishida, '[w]*hat we do shapes what we are* [and] *shapes the world that in turn shapes us.*'[22] While there are important differences to be found between these enactivist theories, as well as others beyond the scope of this dissertation, such as *radical enactivism*,[23] the general consensus is that combined processes within the brain, body, and world are all necessary for cognition. Among these enactivist theories, Noë and, more recently, Miriam Kyselo,[24] are unique in exploring how art can fit into the broader picture of human cognition and experience.

I.3.2 Entrainment

First identified by Christian Huygens (1629 – 1695),[25] entrainment is a period of emergent synchronisation that arises when, as Thaut et al. explain, 'different amounts of energy transferred between the moving bodies […] drives an adjustment process in which the different energy amounts are gradually eliminated to zero until both moving bodies move in

[19] Kevin O'Regan, and Alva Noë (2001). A Sensorimotor Account of Vision and Visual Consciousness, *The Behavioral and Brain Sciences*, 24(5), p.940.
[20] O'Regan, and Noë (2001). *A Sensorimotor Account of Vision*. p.939. See also – Alva Noë (2004) *Action in Perception.* Cambridge, Mass: MIT Press.
[21] Kitarō Nishida, David A. Dilworth, and Valdo H. Viglielmo, trans. (1973). *Art and Morality by Nishida Kitarō.* Honolulu; University Press of Hawaii. p.29.
[22] Maraldo (2017). *Japanese Philosophy in the Making*. p.199.
[23] Daniel D. Hutto, and Erik Myin (2013). *Radicalizing Enactivism: Basic Minds without Content.* Cambridge, Mass.; MIT Press.
[24] Miriam Kyselo (5 September 2024). *Art and its Resonance with Interbeing, Paper* presented at the *Action in Perception 2024 Conference*, University of Helsinki, Porthania, Helsinki, Finland.
[25] Christian Huygens (1707). *Horologium Oscillatorium: Sive, de Motu Pendulorum ad Horologia Aptato Demonstrationes Geometricae Accedunt Ejusdem de Circuli Magnitudine Inventa, et Systema Saturnium* [*Oscillating Clock, or, From the Motion of Pendulums Adapted to Clocks, Geometrical Demonstrations Approach the Same Discovered About the Size of the Circle, and the System of Saturn*]. Oxford; E Theatro Sheldoniano.

resonant frequency or synchrony.'[26] Since Huygens' time, entrainment has been identified on various scales—from the cosmic[27] to the quantum.[28]

More recently, researchers have studied how entrainment occurs between humans and their environments, including other people. Tapping studies, for example, measure people's ability to entrain their finger taps with a rhythmic stimuli.[29] Movement studies extend this to include other forms of rhythmic coordination, such as music, singing, and dancing.[30] Interpersonal studies investigate how people entrain their movements in social contexts, such as when dancing in a group,[31] or when playing music together.[32] On the cusp of modern science, neurobiological studies investigate the brain's ability to entrain, whether it be between neural oscillations[33] or, as we will see, with external rhythmic stimuli such as music, natural spoken languages, the day-night cycle, partner dancing, and do forth.[34]

However, with very few exceptions, studies looking at entrainment typically omit the role of intention. Those studies that do often conflate intentional synchronisation with spontaneous entrainment. As we will see, this is particularly noticeable in art, as artists can intentionally use spontaneous entrainment, even if they are unaware that is this what they are

[26] Thaut et al. (2015). *Neurobiological Foundations.* p. 1.
[27] Rahul Kannan, Mark Vogelsberger, Federico Marinacci, Laura V Sales, Paul Torrey, and Lars Hernquist (2021;2020). Dust Entrainment in Galactic Winds, *Monthly Notices of the Royal Astronomical Society*. 503(1), pp.336 – 343
[28] Albert Cabot, Gian Luca Giorgi, and Roberta Zambrini (2021). Metastable Quantum Entrainment, *New Journal of Physics*. 23(10), pp.1 – 15.
[29] Bruno H. Repp (2005). Sensorimotor Synchronization: A Review of the Tapping Literature, *Psychonomic Bulletin & Review. 12(6),* p.969.
[30] Esther Thelen (1981). Rhythmical Behavior in Infancy: An Ethological Perspective, *Developmental Psychology*. 17(3), pp. 237 – 257; and Bjorn H. Merker, Guy S. Madison, and Patricia Eckerdal (2009). On the Role and Origin of Isochrony in Human Rhythmic Entrainment, *Cortex*. 45(1), pp.4 – 17.
[31] Edith Van Dyck, Dirk Moelants, Michiel Demey, Alexander Deweppe, Pieter Coussement, and Marc Leman (2013). The Impact of the Bass Drum on Human Dance Movement, *Music Perception*. 30(4), pp. 349 - 359. Title.
[32] Gruber Walter, Li Shu-Chen, Lindenberger Ulman, and Müller Viktor (2009). Brains Swinging in Concert: Cortical Phase Synchronization While Playing Guitar, *BMC Neuroscience*. 10(1), pp.1 - 12.
[33] Ryan T. Canolty, and Robert T. Knight (2010). The Functional Role of Cross-frequency Coupling, *Trends in Cognitive Sciences* [online]. 14(11), p.508.
[34] Sylvie Nozaradan, Isabelle Peretz, and Peter E. Keller (2016). Individual Differences in Rhythmic Cortical Entrainment Correlate with Predictive Behavior in Sensorimotor Synchronization, *Scientific Reports*. 6(1), pp.1 – 12.

doing. Therefore, by grounding Nishida and Noë's understanding of art in entrainment, this dissertation demonstrates how the intentional use of spontaneous entrainment can organise and shape the world that organises and shapes what we are.

I.3.3 Consciousness

This dissertation is not about consciousness, nor is it about subjectivity, intentionality, phenomenal experience, qualia, (free) will, and so forth. While these will be touched upon at times, most notably with how Nishida's uses the word "*chokkan*," and how, as a response to Kantian phenomenology, he understands it as a kind of perception that is not distinct from cognition, this dissertation is focused on the metaphysical and ontological aspects of art. Nevertheless, discussing Nishida and Noë's philosophical frameworks demands that we first acknowledge the similar role that consciousness plays in both of their philosophies.

Since the publication of *Zen no Kenkyū*[35] 善の研究 (*An Inquiry into the Good*) in 1911, John C. Maraldo explains that '[w]e may understand [Nishida's] philosophical project overall as an attempt to restore to experience and consciousness the rigor, necessity and universality accorded to logic.'[36] Starting with his concept of "*junsui keiken*" 純粋経験 (pure experience), Nishida developed and refined his thought, often in response to his critics as well as in periods of self-criticism. In *Art and Morality*,[37] for example, Nishida elucidates, as Matteo Cestari explains, his 'concept of the True Self (*shin no jiko*), which cannot be reduced to either subject or object, and rather functions as an activity that unifies all the phenomena of consciousness,'[38] arguing that art and morality arise intuitively from the individual's connection to the world and others. Importantly, *Art and Morality* also marks a shift or

[35] Kitarō Nishida, Masao Abe, and Christopher Ives, trans. (1990). *An Inquiry into the Good*. London, England; Yale University Press.
[36] John C. Maraldo (2024) Nishida Kitarō, *The Stanford Encyclopedia of Philosophy (Spring 2024 Edition).*
[37] Nishida (1973). *Art and Morality.* p.29.
[38] Matteo Cestari (2004). The Problem of Aesthetics in Nishida Kitarō, *Proceedings of the Association for Japanese Literary Studies*. vol.5, p.176.

expansion of Nishida's thought, as the later chapters begin to touch upon topics overtly related to ontology and metaphysics. This ontological turn becomes increasingly prominent in his later works, notably with the publication of *Bashoteki Ronri to Shūkyōteki Sekai-kan*[39] 場所的論理と宗教的世界観 (*The Logic of Basho and the Religious Worldview*) and *Tetsugaku no Konponmondai* 哲学の根本問題 (*Fundamental Problems of Philosophy*). In these works, Nishida retains his interest in consciousness, while transitioning to a more explicit engagement with ontological and epistemological considerations. He articulates key concepts such as the previously mentioned "*basho*," as well as "*zettaimujuntekijikodōitsu*" 絶対矛盾的自己同一 (self identity of absolute contradiction), "*benshōhōtekiippansha*" 弁証法的一般者 (dialectical universal), and the main focus of this dissertation: "*kōiteki chokkan.*"

Noë has maintained a similar interest in consciousness throughout his career. In *Action in Perception*,[40] he builds upon 'A Sensorimotor Account of Vision and Visual Consciousness'[41] to argue that perception is an activity, and that consciousness entails a relationship between the perceiver and the perceived environment, placing him in opposition to Cartesian-inspired metaphysics of mind that posit a duality between mind and world. Like Nishida, Noë asserts that what we perceive is shaped by our active engagement with our environments, in the sense that '[p]erception is not something that happens to us, or in us. It is something we do.'[42] In *Out of Our Heads: Why You Are Not Your Brain, and Other Lessons from the Biology of Consciousness*, Noë targets contemporary neuroscience, specifically addressing the idea of "neural identity theory" that correlate conscious and brain events. Resonating with Nishida, Noë argues that '[c]onsciousness requires the joint

[39] Kitarō Nishida, David A. Dilworth, trans. (1945). *The Logic of Basho and the Religious Worldview*. Tokyo; Iwanami Shoten.
[40] Noë (2004) *Action in Perception.*
[41] O'Regan, and Noë (2001). *A Sensorimotor Account of Vision and Visual Consciousness.*
[42] Noë (2004) *Action in Perception.* p.1.

operation of brain, body, and world,'[43] later adding that 'each plays a critical role in making us the kind of beings we are.'[44]

In *Strange Tools* and *The Entanglement*, Noë turns his attention to art, examining how artistic activities and practices investigate and reorganise our lives. While consistent with his understanding of consciousness, Noë is primarily concerned with the metaphysical and ontological dimensions of art, in 'the work *the art itself* achieves,'[45] and how art continuously shapes the world that, in turn, continuously shapes what we are. While there are fruitful dialogues to be had between Nishida and Noë regarding consciousness, doing so is beyond the scope of this dissertation. Ultimately, the entanglement of art and life, alongside the concept of "*kōiteki chokkan*," remains the main focus of this dissertation, rather than consciousness itself.

4. Research Questions

To address the identified gaps in Nishida and Noë's understanding of art, the following three questions guide this dissertation:

Where do Nishida and Noë agree and, more importantly, disagree about art and its place in our lives?

This question, to be addressed in Chapter 1, recognises that, as David L. Hall and Roger T. Ames explain, 'in the enterprise of comparative philosophy, difference is more interesting than similarity.'[46] While similarities between Nishida and Noë provide a useful starting point, motivating fruitful comparisons, focusing solely on agreement would lead to a descriptive and stagnant analysis. It risks becoming an echo chamber that does not critically engage with

[43] Alva Noë (2009). *Out of Our Heads: Why You Are Not Your Brain, and Other Lessons from the Biology of Consciousness.* New York; Hill and Wang. p.10.
[44] Noë (2009). *Out of Our Heads.* p.184.
[45] Noë (2015). *Strange Tools.* p.167
[46] David L. Hall, and Roger T. Ames (1987). *Thinking Through Confucius*. New York; State University of New York Press. p.5.

or advance beyond their existing ideas. Disagreements, on the other hand, are more informative, as they have the potential to create new and more robust philosophies.

How does entrainment provide a mechanism for understanding Nishida and Noë, and where does it support or challenge their understanding of art and its place in our lives?

This question, to be addressed in Chapters 2 and 3, recognises the potential of entrainment as an empirical example. To support Nishida and Noë's theories, it examines scientific studies and experiments that show how entrainment—through its material, biological, sociohistorical, neurobiological, and neuroecological dimensions—organises our lives. Entrainment offers insights into the underlying mechanisms through which art both organises and gets organised by the world. By investigating the similarities and, crucially, differences between entrainment and Nishida and Noë's philosophies, this approach provides a more concrete framework for examining art and its place in our lives.

How might Nishida and Noë respond to the use of entrainment as an explanatory tool, and what are its limitations as such?

This question, to be addressed in Chapter 4, acknowledges the limitations of using entrainment as an empirical example. It identifies the ontological and philosophical assumptions underlying scientific studies of entrainment, and considers how Nishida and Noë might critique or respond. By exploring these limitations and possible objections, this question highlights the need for alternative approaches, as well as the need to refine the application of entrainment in understanding art. This also builds a foundation on which the similarities and overlap between Nishida and Noë can rest, while also showing relationship between science and philosophy.

Overview

1. Methodology

This dissertation contrasts Nishida and Noë's understanding of art, and grounds them both in the phenomenon of entrainment through two methodological approaches: comparative analysis and explanatory modelling.

1.1 Comparative Analysis

The first methodological approach is comparative analysis. Nishida and Noë, while tangentially connected by their identifiably enactivist understanding of art—or rather, by the *Mahāyāna* Buddhist tradition from which early enactivism borrows—are both situated within historically, geographically, and culturally divided philosophical traditions. Nishida, for instance, contrasts Western and Eastern thought by stating that 'we can distinguish the West to have considered being as the ground of reality, [and] the East to have taken non-being of nothingness as its ground.'[47] Although comparative philosopher William Ernest Hocking (1873 – 1966) challenges such simplistic divides, arguing that 'the philosophical "synthesis of East and West" has probably occurred already, and more than once,'[48] Nishida's point is that engaging with philosophies from historically divided cultures can often reveal fundamental differences.

This methodological approach, informed by Hall and Ames, shall identify similarities while emphasising differences. While similarities between Nishida and Noë, and their respective traditions, will be shown to exist, this methodology emphasises the differences between, as these offer, as Hall and Ames explain, 'more fruitful subject of philosophic

[47] Nishida Kitarō (1933; 1934). The Forms of Culture of the Classical Periods of East and West seen from a Metaphysical Perspective by Nishida Kitarō, In - Dilworth, Viglielmo, and Zavala, ed. & trans. (1998). *Sourcebook for Modern Japanese Philosophy*. p.21.
[48] William Ernest Hocking (1952). On Philosophical Synthesis, *Philosophy East & West*. 2(2), p.100.

reflection than […] shared assumptions.'[49] Though agreement, as previously mentioned, will serve as a good starting point, it is where Nishida and Noë disagree that fosters the creation of novel and more resilient philosophies.

This comparative methodology is also applicable when comparing Nishida and Noë's philosophies with the phenomenon of entrainment, as the differences between there theories can identify implicit assumptions in both science and philosophy, as well as showing how material and biological explanations are insufficient to *fully* explain the social and historical world. Therefore, when comparing Nishida and Noë's understanding of art, and when grounding both in the phenomenon of entrainment, we should recognise similarities and prioritise differences, as fruitful comparisons can be made therein.

1.2 Explanatory Modelling

The second methodological approach is explanatory modelling. This methodology, as Michael Weisberg explains, 'is a form of surrogate reasoning where target systems in the natural world are studied using models, which are similar to these targets.'[50] This approach simplifies complex systems into their core elements, making it easier to understand how, in the case of entrainment, the whole organises the behaviour of its parts and the parts organise the behaviour of the whole. While explanatory modelling can use mathematical and computational methods, it can also use conceptual models to explain complex phenomena, as will this dissertation.

When looking at the phenomenon of entrainment, and how it grounds Nishida and Noë's understanding of art, explanatory modelling is crucial. Although the models created for this dissertation are intentionally simplified—often reducing highly complex systems to their

[49] Hall, and Ames (1987). *Thinking Through Confucius*. p.5.
[50] Michael Weisberg (2015). Biology and Philosophy Symposium on Simulation and Similarity: Using Models to Understand the World: Response to critics, *Biology & Philosophy*. 30(2), p.299.

most basic elements—they are created to explain the dynamics of entrainment in large and intricate systems.

For example, when modelling the complexities of the human brain in Chapter 3, this approach begins with a single neuron, then progresses to the electrical activity between two neurons, then four, then eight, and so on, exponentially increasing the model in size to include the electrical activity of thousands of neurons and between neural oscillations. This method acknowledges the immense complexity of the human brain, while aiming to explain and clarify how, in principle, the phenomenon of neural entrainment takes place.

While intentionally simplified, this modelling serves an important purpose. By simplifying neural networks, it provides a clear framework for explaining how entrainment occurs across different levels of complexity and at various scales. This model, alongside many others to be developed in Chapters 2 and 3, is not intended to capture every nuance of entrainment, or of the target systems, but rather to explain how the phenomenon occurs and how parts can both organise and get organised within wholes. Therefore, explanatory modelling offers valuable insights into the phenomenon of entrainment, and how it can ground Nishida and Noë's comparable understanding of art.

2. Chapter Contents

Chapter 1 examines Nishida and Noë's comparable understanding of art. It is argued that, when placed in dialogue, their shared perspectives provide a way to understand how actions and intuitions both shape and are shaped by the world. This chapter also highlights where Nishida and Noë fundamentally disagree, specifically about the role of the artist in the creative process. For Noë, art is the creation of a preexisting artist that then (and only then) works to reorganise life, whereas, for Nishida, both art and artist create, persist, and unfold within a world that both includes and transcends the artist and their creation. By placing both

authors in dialogue, with each other as well as with their critics, this chapter develops a more robust theory of art, as well as a deeper understanding of the world of action and organisation that emerges from their shared and contrasting perspectives. This, in turn, sets the stage for a more grounded investigation into the potential mechanisms underlying Nishida and Noë's world of action and organisation.

Chapter 2 introduces the phenomenon of entrainment as an empirical example of Nishida and Noë's world of action and organisation. By looking at examples in the material, biological, and sociohistorical world, entrainment is defined as an *open*, *resonating*, *dissipating*, *emergent*, and *rhythmic* system. This system gives rise to periods of spontaneous and emergent organisation through ETMs such as conduction, radiation, convection, or advection. This chapter also argues that, within an entrained system, '[w]holes are more than the sum of their parts'[51] and '[p]arts behave differently in wholes,'[52] thus exemplifying Carl Gillett's theories of emergence and 'downward machretic determination.'[53] Using explanatory modelling to describe the entrainment between two pendula, within a murmuration of starlings, and with pedestrians crossing the London Millennium Footbridge on June 10th, 2000, this chapter shows how wholes can "pull up" the behavior of their parts, just as parts can "pull down" the behavior of wholes, thus showing how organised activities both shape and are shaped by their constituent parts.

Chapter 3 offers neuroecological entrainment as an empirical framework for understanding how actions and intuitions organise the world which, in turn, organises actions and intuitions. This chapter argues that neuroecological entrainment, which includes the brain, sensorineural system, sensorimotor system, and environmental stimuli, reveals that emergent synchronisation and organisation between humans and their surroundings can be

[51] Carl Gillett (2016). *Reduction and Emergence in Science and Philosophy*. Cambridge University Press. p.201.
[52] Gillett (2016). *Reduction and Emergence*. p.201.
[53] Ibid. p.234.

initiated and sustained by the rhythmic transfer of energy. Examples of acoustic and optical stimuli, including other people, will show how entrainment is ubiquitous in our lives, often "pulling up" our neurobiology in both profound and subtle ways, while also influencing our actions and cognitive processes. This chapter concludes by highlighting the limitations of current scientific studies on entrainment, especially those involving interpersonal and intentional synchronisation, thus setting the stage for Nishida and Noë's theories about art.

Chapter 4 starts by explaining Nishida's explicit rejection of positivist ontologies and assumptions. The chapter also explores Nishida's underdeveloped philosophy of science, deeming it to be suggestive but ultimately elusive. Noë's *aesthetic paradigm* is given as a middle way between positivism and Nishida's view, arguing that science is inherently cultural, and that subjectivity is a fundamental part of scientific inquiry. Building upon this, this chapter distinguishes between spontaneous entrainment, intentional synchronisation, and intentional spontaneous entrainment, arguing that spontaneous entrainment is a tool that artists can intentionally use, even if only tacitly, to shape the organised activities that continuously shape what we are. The central thesis of this chapter, and of the dissertation as a whole, is that art, life, and entrainment are entangled, and that this entanglement shapes what we are: an aesthetic phenomenon.

Chapter 1: The *Work* of Art for Nishida Kitarō and Alva Noë

Art encompasses a vast range of human activities. From Michelangelo (1475 – 1564) chiselling a block of marble to reveal the form hidden within, to Anna Pavlova's (1881 – 1931) inspired performance of *The Dying Swan,*[54] from the contemplative prose of Fernando Pessoa's (1888 – 1935) *The Book of Disquiet*,[55] to the macabre and haunting *Black Paintings*[56] of Francisco de Goya (1746 – 1828), art invites us to explore what it means to be human. This invitation spans not only Western traditions, but also Japanese arts such as *bushidō* 武士道 (warrior way), *aikidō* 合気道 (way of peace), *jūdō* 柔道 (gentle way), *sadō* 茶道 (way of tea), *kadō* 華道 (way of flowers), and many more. Of course, neither tradition serves as a standard for the other, as each can contribute equally to our understanding of humanity. Each work of art, whether Western, Eastern, or otherwise, invites us to appreciate and cultivate what it means to be human. However, not everything created is a work of art. We humans also create pollution, war, discrimination, and inequalities, alongside the technologies, laws, and systems of government that can, hopefully, address them.

What, then, differentiates art? In *Strange Tools*, Noë explains that what makes art art is what 'the work *the art itself* achieves.'[57] In other words, we can identify art by looking at what it does rather than by what it is. For Noë, the work of art is 'to bring out and exhibit, to disclose and illuminate, aspects of the way we find ourselves organized.'[58] Nishida offers a similar understanding in *Fundamental Problems of Philosophy*, explaining that 'the work of

[54] Royal Opera House (2020). The Dying Swan – Natalia Osipova (The Royal Ballet), *YouTube*.
[55] Fernando Pessoa, and Richard Zenith, trans., ed. (2015) *The Book of Disquiet*. London; Penguin Books.
[56] Elke Linda Buchholz (1999). *Francisco de Goya: Life and Work*. Cologne: Könemann. pp.76 – 83.
[57] Noë (2015). *Strange Tools.* p.167
[58] Ibid. p.16

art is not a thing, but a process, something lived. And yet a work of art exists apart from the person as a thing […]. And accordingly, it too acts directly on the person.'[59] Like Noë, Nishida suggests here that art can be identified by what it does rather than by what it is, and that it works to both reveal and shape our lives. Consequently, this chapter argues that Nishida and Noë share a comparable understanding of art and its place in our lives, with both recognising art as a paradigm example of how actions and intuitions shape and organise the world that, in turn, shapes and organises actions and intuitions.

Section one explains Nishida's novel concept of "*kōiteki chokkan*." In this section, the art of dance, what Noë calls 'capital-D Dance,'[60] is used to exemplify how, for Nishida, artistic actions and intuitions shape the world that also shapes artistic actions and intuitions.

Section two explains the logic or dialectic of *soku hi* 即非 (is and is not), showing how, for Nishida, it is the underlying structure that unifies *kōiteki* and *chokkan*, as well as all of reality. *Soku hi* unifies the ontological and logical contradiction between what is and what is not, between the individual and the world, and between action and intuition. We will return to this topic in Chapter 4, Section 1.2.3, when discussing Nishida's ontology, and how *soku hi* highlights the congruent relation between reality and logic, albeit in a very different kind of correspondence than advocated for in Western traditions.

Section three explains Noë's understanding of art. Once again, the example of Dance is used, this time to show how, for Noë, art is informed by the organised activities it seeks to alter. Art, for Noë, investigates, disrupts, and potentially reorganises the organised activities that shape our lives and, as we will see in Chapter 4, Section 2, what we are.

[59] Nishida (1970). *Fundamental Problems of Philosophy*. p.129.
[60] Alva Noë (2021). Entanglement and Ecstasy in Dance, Music, and Philosophy: A Reply to Carrie Noland, Nancy S. Struever, and Thomas Rickert, *Philosophy & Rhetoric*. 54(1), p.65.

Section four provides a comparative analysis of Nishida and Noë's philosophy, establishing where both agree and, crucially, where they disagree. It will be shown that Nishida and Noë largely agree that actions and intuitions both shape and are shaped by the world, while disagreeing about the role of the artist in the creative process.

Section five looks at two common criticisms directed at Noë: (1) Art has many functions other than those he describes, and (2) Art does not necessarily disrupt how we humans live. Examples of traditional Japanese arts will be used to support these criticisms, as they exemplify how art is not necessarily a strange tool, as argued by Noë, but also an everyday or ordinary tool.

Section six gives a rejoinder to the previous criticisms, highlighting how Nishida and Noë's shared perspective reveals how art shapes and is shaped by the world in both strange and ordinary ways. This section concludes by indicating how Noë can also address the criticism that Nishida's terminology implies a kind of psychologism.

The core aim of this chapter is to establish the commonalties between Noë and Nishida's understanding of art, as well as where they disagree. When placed in dialogue, they offer a way to understand how our actions and intuitions organise the world which, in turn, organises our actions and intuitions. This creates a more robust theory of art, while also setting the stage for a more grounded investigation into the potential mechanisms underlying our actions and intuition, both in and with the world, in later chapters.

In Chapters 2 and 3, entrainment will provide such a mechanism, showing how the phenomenon of entrainment is a whole that organises the behavior of its parts which, in turn, organises the behavior of the whole. Building upon this, Chapter 4 will show how art, life, and entrainment are entangled, and how this entanglement shapes and organises what we are.

Section 1: The *Work* of Art for Nishida Kitarō

For Nishida, art is something created both in and with the world. Art is a creative activity that shapes the world which, in turn, shapes the creative activity of art. In *Fundamental Problems of Philosophy*, Nishida explains that 'the work of art is not a thing, but a process, something lived. And yet a work of art exists apart from the person as a thing […]. And accordingly, it too acts directly on the person.'[61] What Nishida is saying here is that art is something we do in and, importantly, with the world. On one hand, the world shapes the creative activities of the artist. On the other hand, the creative activities of the artist shape the world. This is because, for Nishida, the creation of art is situated within the physical, biological, social, and historical world. Art is shaped by an artist's lived experience, as is the world also shaped by what the artist creates.

Nishida's understanding of art is firmly grounded in his life-long pursuit to explain reality and our place within. In the preface to *An Inquiry into the Good*, added 10 years after its original publication, Nishida contemplatively writes: 'That which I called in the present book the world of direct or pure experience I have now come to think of as the world of historical reality. The world of action-intuition [i.e., *kōiteki chokkan*] is none other than the world of pure experience.'[62] In the world of *kōiteki chokkan*, for Nishida, our actions in and with the world shape what we think, just as what we think shapes our actions in and with the world. This is the world wherein artists create. Thus, for Nishida, we exist as part of the world of both *kōiteki* 行為的 and *chokkan* 直観, of both action and intuition.

1.1 The World of Kōiteki Chokkan

As a union of the two words "*kōiteki*" and "*chokkan*," Nishida's novel concept resists conclusive translation. In 'Enaction in Cognitive Science and Nishida's Turn of Intuition into

[61] Nishida (1970). *Fundamental Problems of Philosophy*. p.129.
[62] Kitarō Nishida (1921). Preface to the Second Edition, In –Nishida (1990). *An Inquiry into the Good*. pp.xxxii - xxxiii

Action,'[63] Maraldo offers six possible translations—action-intuition, active intuition, acting intuition, action-oriented intuition, performative intuition, and enactive intuition—before finally conceding that none are sufficient to fully encapsulate the nuances of *kōiteki chokkan*.[64] Similarly, in 'The Knowing Body: Nishida's Philosophy of Active Intuition (*Kōiteki Chokkan*),'[65] Matteo Cestari wrestles through a number of different conceptual interpretations, finally concluding that the true meaning of *kōiteki chokkan* may be somewhere in-between. Yet, while *kōiteki chokkan* resists conclusive translation, the idea underpinning it is as profound as it is simple: we exist within '*a world in which that which is made makes that which makes*,'[66] and where, as Maraldo previously gave, '[w]*hat we do shapes what we are, shapes the world that in turn shapes us.*'[67]

Evidently this goes far beyond the creation of art. For Nishida, *kōiteki chokkan* suggests a reciprocity between all of our actions, thoughts, and perception, permeating within and throughout the world. John W. M. Krummel, in his introduction to *Place and Dialectic: Two Essays by Nishida Kitarō*, explains further, writing that 'Nishida distinguishes this world into the three levels of material, biological, and historical, which are in fact standpoints for viewing the same world.'[68] While this tripartite structure will be important in Chapter 2, the relevant point here is that, for Nishida, this is the world we create art in and with. It is the vast world of *kōiteki chokkan*, wherein what we can and will create is shaped by material, biological, social, and historical processes that both transcend and include our individual creative activities.[69] Accordingly, the world around us shapes us as individuals, as we do it.

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[63] Maraldo (2017). *Japanese Philosophy in the Making.* Chapter 7.
[64] Ibid. p.200.
[65] Matteo Cestari (1998). The Knowing Body: Nishida's Philosophy of Active Intuition (*Kōiteki Chokkan*), *The Eastern Buddhist*. 31(2), pp.179 – 208.
[66] Nishida (1937). *The Historical Body*. p.48.
[67] Maraldo (2017). *Japanese Philosophy in the Making*. p.199.
[68] John W. M. Krummel (2012). *Basho*, World, and Dialectics: An Introduction to the Philosophy of Kitarō Nishida, In – Nishida Kitarō, John W. M. Krummel, and Shigenori Nagatomo, eds. & trans. (2012). *Place and Dialectic: Two Essays by Nishida Kitarō*. New York; Oxford University Press. p.31.
[69] Nishida (1970). *Fundamental Problems of Philosophy*. p.20.

Therefore, for Nishida, the world of *kōiteki chokkan* both includes and transcends our individual actions and intuitions. To provide a deeper understanding of *kōiteki chokkan*, it shall be beneficial to look at its constituent parts, *kōiteki* and *chokkan*, and how each is instantiated in art.

1.2 Chokkan as Intuition

An action, a performance, a production, a creation, and intrinsic to them all, intuition. This first insight is at the core of *kōiteki chokkan*. It explicitly links what we do with what we think. Notably, the direct English translation of the word "*chokkan*," "intuition," carries semantic baggage. Derived from the Latin *intuitus*, meaning immediate or direct knowledge or insight,[70] the word "intuition" can imply a mind separate and distinct from the world. Dependent on one's philosophical predisposition, this could be understood as a cognitive state or process, as a conscious or phenomenal state, or even as the feat of an immortal soul. What all these have in common is that intuition is deemed to be merely an *a priori* state or process distinct from the world.

However, while this does partially capture what Nishida has in mind when he uses the word "*chokkan*," he has a much more expansive and active understanding. To fully understand Nishida's usage, it is important to first recognise that he is engaging with Kantian phenomenology, specifically Kant's articulation of intuition (*anschauung*) as a passive engagement with the perceived world. In *The Critique of Pure Reason*, Kant argues: 'In cognition there are two elements: firstly, the conception, whereby an object is cogitated […]; and, secondly, the intuition, whereby the object is given.'[71] Simply put, for Kant, intuition is a passive and pre-conceptual reception of sensory data that then gets processed by cognitive

[70] Charles Talbut Onions, ed. (1983). *The Oxford Dictionary of English Etymology*. United Kingdom; Oxford University Press. p.483

[71] Immanuel Kant, and J. M. D. Meiklejohn, trans. (1781; 2021). The Critique of Pure Reason, *Project Gutenberg*. Section 18.

faculties. This, for Kant, is a prerequisite for cognition, while also remaining distinct. In short, intuition is a passive way of receiving the world. The relevant point here is that, for Nishida, intuition is active and embodied, including all physical, cognitive, and perceptual actions. By combining intuition with action, Nishida moves away from the passivity of Kant's "intuition." Accordingly, Nishida reinterprets Kant's understanding, situating intuition as an active part of the active world.

While Nishida only refers to *ninchi* 認知 (cognition) a handful of times in his vast corpus, his use of the word "*chokkan*" is related, albeit a far more embodied, enacted, and active kind of cognition that includes our sensorimotor systems and the active world. Maraldo explains that 'Nishida's intuition somehow involves action […] while retaining its traditional link to cognition, only this time a cognition placed not in the mind.'[72] What Maraldo highlights here is that, for Nishida, intuition arises through our active engagement with and in the active world. For Nishida, intuition is linked with activity, be it physical, cognitive, or perceptual, as all arise both in and with the world. Notably, this expanded understanding of cognition involves the interplay of perception and action. Perception is not distinct from cognition or action, as Kant's "intuition" suggests, but a form of cognition that involves our sensorimotor engagement with the world. Thus, for Nishida, intuition is embodied, including action, perception, and, more generally, cognition as sensorimotor engagement both in and with the world.

Nishida, resonating with enactivist theories, sensorimotor enactivism in particular, expands further, stating that 'true intuition appears through our action, but at the same time it determines our action.'[73] Put another way, intuition is shaped by action, and, likewise, action is shaped by intuition. What we think is shaped by what we do, and what we do is shaped by

[72] Maraldo (2017). *Japanese Philosophy in the Making*. p.204.
[73] Ibid. p.173.

what we think. This relationship between the individual and the world, between action and intuition, is one of mutual reciprocity, whereby one is shaped by the other. As such, for Nishida, intuition and cognition are placed in the wider context of a world that both includes and transcends the individual. This will become increasingly important in subsequent sections, as it indicates how the activities of the world and of the artist are one and the same, and how what we do as individuals shapes the activities of the world which, in turn, shapes what we do as individuals.

Nonetheless, for the moment, Nishida gives that '[t]he world of intellectual objects is to be derived from that world of personal action.'[74] Hence, intuition is not confined to some arbitrary membrane, like a brain, a head, or even a body. Nor is intuition some quasi-Cartesian "thing" separate from the world. Intuition is an activity. It is the activity of the world, as is it the sensorimotor activity of the individual. As will be discussed in Section 1.4 of this chapter, as Nishida understands it, action not just physical movement, as it is a broader category of activity that includes thought, perception, and interaction with the world. In this context, intuition is an activity that arises from what that we do in and with the active world.

1.2.1 Chokkan as Artistic Intuition

For Nishida, art is a paradigm example of intuition, and how it is intrinsically linked to action. The creation of art, what Nishida often refers to as 'aesthetic intuition'[75] or 'artistic intuition,'[76] is when the artist takes in, or intuits, the world around them. In so doing, what is and can be conceivably created is shaped by their actions in and with the world. Nishida explains that '[i]n artistic activity we neither structure things conceptually nor imitate things merely passively. Things beckon and move us.'[77] In other words, the world offers art to the

[74] Nishida (1970). *Fundamental Problems of Philosophy*. p.3.
[75] Ibid. p.173.
[76] Ibid. p.178.
[77] Ibid. p.179.

artist, in the sense that what is and can be conceived is shaped by their activities in and with the creative world.

For example, in the art of dance, what Noë calls 'capital-D Dance,'[78] artistic intuition is instantiated. According to Nishida, the creation and performance of Dance is not merely the individual achievement of a preexisting artist. It is something the objective world offers by way of an artist's activities within. What the Dance artist can and will conceivably do arises from their activities in a world which, once again, 'both transcends and includes personal action.'[79]

The performance of a ballet, for instance, is shaped by the historical world, in that what has come before informs what ballet is and can be. Lost to antiquity, the history of ballet, and of Dance more generally, transcends and includes any individual performance of a Dancer.

The performance of ballet is also shaped by the social world. For good and bad, the performance of ballet is shaped by the music offered by an orchestra, by the cheers and lamentations of the audience, by the other performers on stage, and even by those who have come before, such as teachers, friends, and family.

While the link between audiences and performances is made explicit in interactive choreography such as, for example, *Storytime Ballet: Cinderella* from The Australian Ballet,[80] this is more obvious in other art forms, such as jazz or stand-up comedy, where the performer more-or-less explicitly uses audience reactions to inform and shape their performance. For Nishida, the historical and social worlds are just different standpoints,

[78] Noë (2021). *Entanglement and Ecstasy in Dance*. p.65.
[79] Nishida (1970). *Fundamental Problems of Philosophy*. p.20.
[80] This link between audience and performance is made explicit in the interactive choreography of – The Australian Ballet (2024). *Storytime Ballet: Cinderella.*

leading him to eventually combine the two into what he would call the 'the socio-historical world,'[81] this being the world of our lived experience, culture, society, and so on.

The performance of ballet is also shaped by the material world, to the extent that physical limitations of the Dancer and of the physical world, combined, shape what can be conceivably done. This is what Nishida means when he gives that '[t]he more deeply we penetrate the depths of desire or impulse, the more they transcend our consciousness and exist beyond us,'[82] as artistic intuition belongs as much to the objective world as it does to the artist. When the artist intuits the world around them, they take in what the world offers and let it shape their activities.

Consider *noh* 能 (skill, or talent) theatre, a traditional Japanese performance art that includes singing and dancing.[83] Like ballet, the creation and performance of *noh* is not solely the work of a preexisting artist, but a response to the world in which the artist is situated. The performance of *noh* is shaped by the historical world, to the extent that this form of art can be dated back to at least the 14th century, with the prescribed structures of *jo-ha-kyū* 序破急 (beginning, break, and rapid) informing what *noh* is and can be. The form and style of *noh* theatre is influenced by centuries of tradition, past performances, and a longstanding collective cultural heritage. The performance of *noh* is also shaped by the social world as, like ballet, performances are shaped by the music offered by musicians, the reaction of the audience, and even by those who have come before. Performances of *noh* are also shaped by the physical world, as the very nature of the performance—its slow, deliberate movements, the masks worn by the actors, and the use of minimal props—exemplifies the limitations and possibilities offered by the physical environment. The constraints of the stage and costumes,

[81] For a comprehensive overview of how Nishida refined the idea of a sociohistorical world near the end of his life, see – Krummel (2012). *Basho, World, and Dialectics*. pp.28 – 30.
[82] Nishida (1970). *Fundamental Problems of Philosophy*. p.179.
[83] For a comprehensive exploration of *noh*, see - Faubion Bowers (1974). *Japanese Theatre*. Rutland, Vermont; Charles E. Tuttle Co. Chapters 6 and 7.

the intricacies of the physical movements, and the use of space, all of these things contribute to what is performed, to the extent that the physical limitations of the artist and of the physical world, combined, shape what can be conceived.

However, relative to ballet, innovation in *noh* is limited by the *iemoto* 家元 (family foundation) system, where what is and can be performed as *noh* is strictly dictated by Grand Masters. An obvious example being that, traditionally, *noh* performers are always male. Yet, while innovation is relatively small in the performance itself, especially when compared to ballet, *noh* theatre is a highly ritualistic form of art that invites the audience to experience the performance not merely as passive observers, but as active participants in a larger cultural and social framework. Accordingly, *noh*, like ballet, exemplifies how the artist's intuition, action, and the world around them are intricately linked. The creation of both is not a solitary act but an interaction with and in the historical, social, and material world.

This is why Nishida thinks that art is a paradigm example of *kōiteki chokkan*, as art, when at its best, arises when the artist gets out of the way and allows the world to create through them. Indeed, this is exactly why many artists practice their craft. Never is art created solely for its own sake. It is always created in, with, and for the objective world. We will return to this in Chapter 4, Section 1.2, where Nishida's concept of "*hyōgen teki kankei*" 表現的関係 (interexpression) will be shown to provide a comprehensive understanding of the artist's immersion into the objective and active world. This is why Nishida explains in *Fundamental Problems of Philosophy* that 'aesthetic intuition may be regarded as intuition in the best sense,'[84] as it arises from artists' activities in and with the world. Thus, for Nishida, the world is our muse and we its intuited conduits.

[84] Nishida (1970). *Fundamental Problems of Philosophy*. p.173.

1.3 Kōiteki as Activity

An intuition, a thought, an idea, a judgment, an experience, and intrinsic to them all, activity. This second insight, like the previous, is at the core of *kōiteki chokkan*. Just as intuition is shaped by action, so too is action shaped by intuition for Nishida. However, as with *chokkan*, a direct English translation of the word "*kōiteki*," "active," is not without semantic baggage. To be active seems to imply a world wherein one is active. A world of cause and effect, where ontologically distinct objects interact with each other in a linear and chronological manner.

However, this is not what Nishida has in mind when he uses the word "*kōiteki*." While Nishida does agree that we act in the world as individuals, this only accounts for the personal component of the objective world. To reiterate, for Nishida, we act and intuit a world that both transcends and includes all subjects, including ourselves. This means that the activities of the individual are instantiations of the activities of the world, and that there is no duality to be found between mind and world, only ambiguity. We will return to this in Chapter 4, Section 1.2, as Nishida's predicate logic and 'infinite continuity of acts'[85] will show that action and intuition are both congruent *acts* entailed within the unfolding and active reality. Thus, for Nishida, to be an active individual is to be an active part of an active world that both includes and transcends us.

This means that, like intuition, action belongs as much to the world as it does to the individual. We act in and with an active world that acts in and with us. Action is shaped by intuition. Intuition is shaped by action. Both are shaped by and within the active world. Put another way, our actions shape the world which shapes our actions. This means that actions cannot be attributed merely to the individual. Or anywhere else for that matter. Actions do not arise merely from the subjective, conscious, or cognitive individual, nor do they merely

[85] Nishida (1973). *Art and Morality.* p.79.

arise from the objective or inanimate world. They are enacted by the world and the individual. This means that, for Nishida, our actions are not determined by a mind cut off from the world. Nor are they determined by a world from which the mind is cut off. Our actions are offered, if not afforded, by the fact that we are an active part of the active world. Not only does Nishida's understanding blur the line between action and intuition, as well as mind and world, it erases it. There is no conclusive line to be found between the individual the world, between action and intuition, only ambiguity.

1.3.1 Kōiteki as Artistic Activity

For Nishida, art is a paradigm example of how intuition is intrinsically linked to action, as he explains that 'the world is a creative process [a]nd our body is a creative element of that world.'[86] Just as artistic intuition is a paradigm example of *kōiteki chokkan*, Nishida is saying here that artistic activity exemplifies how all actions are situated in a world where we both act and are acted upon. A world where individual actions shape the world that both transcends and shapes individual actions. For Nishida, artistic creation is such an activity, as it arises when the artist acts and intuits the world.

In this way, the world evokes and beckons creative activities. Art arises from the artist's activities in and with the creative world. The world shapes artistic creativity, as does an artist's creativity shape the world. Artistic activities do not arise merely from the individual artist, nor do they arise merely from the world, but rather from the vagueness and ambiguity between both. We act and create art in a world that acts and creates in us by way of artistic intuition. Art shapes the world which, in turn, shapes art.

Consider *Xī Shān Xíng Lǚ Tú* 杖藜遠眺 (*Poet on a Mountaintop*), the Chinese Landscape Painting by Shen Zhou 沈周 (1427-1509). Depicted in this painting is a scene of

[86] Nishida (1937). *The Historical Body*. p.48.

a solitary man, presumably Shen Zhou, standing atop a rocky mountain obscured by clouds. In the distance, the silhouette of other mountains, or perhaps clouds, likely both, blend into the canvas. In the foreground, a solitary temple stands shrouded between mountains, trees, and clouds. No such vista can be found in the mountains of *Suzhou* 苏州市, the region of China where Shen Zhou lived his entire life and where he found the inspiration for his painting.[87] This is because *Poet on a Mountaintop* is not meant to be an exact depiction of the world, a mere snapshot or singular perspective. Instead, Shen Zhou aimed to capture the true nature of the mountains of *Suzhou*, capturing and expressing all perspectives and none in his work.

In *The Great Image has no Form, or on the Nonobject through Painting*, François Jullien explains how this has been traditionally done:

> To paint is not to apprehend the mountain "in one locale" and from a "single corner" […]. It is to paint the mountain after climbing many a hill and sketching many a varied mountaintop, after having one's fill of hikes and vistas, after letting the infinite forms and resources of the mountain ripen one's spirit.[88]

Shen Zhou, having had his fill of walking (hiking is relatively recent in Japan) the mountains of Suzhou, had a deep familiarity with its many vistas. This familiarity informed and shaped each one of his brush strokes.

In Nishida's terminology, *Poet on a Mountaintop* was a creation that arose from Shen Zhou's activities in and with the world. Shen Zhou's artistic activities in the mountains of *Suzhou* gave rise to his artistic intuitions, just as his artistic intuitions gave rise to each one of his brush strokes. In this way, as Nishida explains, 'the mountains and the rivers must also be

[87] Richard Edwards, and Henning von Mirbach (2003; 2023). Shen Zhou, *Grove Art Online*.
[88] François Jullien, and Jane Marie Todd (2009). *The Great Image has no Form, or on the Nonobject through Painting*. Chicago; The University of Chicago Press. p.55.

expressive,'[89] as the creation of *Poet in a Mountaintop* belongs as much to the world as it did Shen Zhou. Thus, when painting, Shen Zhou's actions shaped his intuitions, as did his intuitions shape his actions. In this way, the world beckoned Shen Zhou to create *Poet on a Mountaintop*.

Poet on a Mountaintop also beckons to us, the viewer. It invites us to experience, to truly know, the greatness of the mountains of *Suzhou*. Not from any one perspective, but with an appreciation for all. Having all perspectives and none, this painting evokes artistic intuitions in the viewer, in the sense that actively viewing it allows us to intuit the world along with Shen Zhou.

Similar to *Poet on a Mountaintop*, in the example of Dance, a created performance cannot be attributed solely to the artist. It is something that the world offers by way of the activities of an artist within. The physical or material world shapes what Dance both is and can be, to the extent that the shared physical limitations of dancer and of the world shape what is and can be conceivably done. In the performance of ballet or *Noh*, what a Dancer can and will do, regardless of skill or intent, operates within the shared physical limitations of the Dancer and of the world. While this may differ from person to person, as well as with age, no Dancer can, for example, stay fixed in the air—as much as they might try, all are subject to gravity.

Nishida's perspective here bears a similarity to the idea of "affordances," first posited by James Gibson in *The Ecological Approach to Visual Perception.*[90] For Gibson, '*affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill.'[91] However, while Nishida aligns with Gibson when he previously gave

[89] Nishida (1970). *Fundamental Problems of Philosophy*. p.35.
[90] James Gibson (2015). *The Ecological Approach to Visual Perception*. New York: Psychology Press.
[91] Gibson (2015). *The Ecological Approach*. p.119.

that '[t]hings beckon and move us,'[92] his kind of affordance is much more active and dynamic. More importantly, Nishida rejects Gibson's implicit duality between animal and environment. While a subtle difference, this is an important one. This is because, when the artist performs, they take in what the world offers and let it shape their activities. In this sense, art is more enacted than afforded.

Nishida explains that '[a]ction is the objectification of subjectivity and the subjectification of objectivity. It must be a kind of practice. Practice always is the union of subject and object. […] The creative activity of the artist is a paradigm of this.'[93] In other words, art, when it is at its best, arises when artists get out of the way, thereby allowing the world to act and create through them by way of the individual actions and intuitions it offers. Indeed, this is exactly why many artists practice their craft, and why Nishida considers art to be a paradigm example of *kōiteki chokkan*. Thus, for Nishida, the active world is our muse, and we are its active conduits.

1.4 Summary and Context

Nishida's novel concept "*kōiteki chokkan*" offers insights about the world and our place within. It shows how what we do and think are inextricably linked with a world that both transcends and includes our actions and intuitions. This is because, as Nishida gave, 'the world is a creative process. And our body is a creative element of that world.'[94] While we all shape the world which, in turn, shapes us, this is something that many artists explicitly train to do. By practicing their craft, artists aim to allow the world to create through their actions and intuitions. Thus, the concept of "*kōiteki chokkan*" offers insights about the unity of action and intuition, challenging conventional distinctions between art and artist, creator and created, perceiver and perceived, and, more fundamentally, between cognition and the world.

[92] Nishida (1970). *Fundamental Problems of Philosophy*. p.179.
[93] Ibid. pp.118 – 119.
[94] Nishida (1937). *The Historical Body*. p.48.

Section 2: The Logic of *Soku hi*

Kōiteki and *chokkan*, action and intuition, creator and created, perceiver and perceived, cognition and world, and, between them all, reciprocity. While *kōiteki* and *chokkan* are intrinsically and inseparably linked for Nishida, one does not modify the other. Nishida explains that '[i]n action, subjectivity determines objectivity; in thought, objectivity determines subjectivity. In such a sense, we can even say that the two are contradictory.'[95] In other words, it is not that action modifies intuition, or that intuition modifies action, but that both are unified. This is *soku hi*.

2.1 Soku hi: The Unity of Contradictories

This mutual reciprocity between *kōiteki* and *chokkan* is firmly grounded in the philosophical and religious traditions that Nishida is working within. Explicitly influenced by the *Mahāyāna* Buddhist text, *Vajracchedikā Prajñāpāramitā Sūtra*[96] वज्रच्छेदिकाप्रज्ञापारमितासूत्र, Nishida explains that his 'concept of God [i.e., Reality] is a self-identity of absolute contradiction which includes absolute negation in itself. The *Prajñāpāramitā Sūtra's* dialectic of *soku hi* best expresses this.'[97] When attempting to translate "*soku hi"* to English, it immediately becomes evident that this is a misguided endeavour. Where the words "*kōiteki*" and "*chokkan*" resisted conclusive translation, "*soku hi*" outright refuses. This is because typical English translations, such as "is and is not," "is not, yet is," as well as "is, yet is not," all fail to fully capture the logical and ontological complexities of *soku hi* as a concept.

[95] Nishida (1970). *Fundamental Problems of Philosophy*. p.200
[96] Red Pine (2001). *The Diamond Sutra: The Perfection of Wisdom*. United States; Counterpoint Berkley.
[97] Kitarō Nishida, and David A. Dilworth, trans. (1970). Religious Consciousness and the Logic of the Prajñāpāramitā Sūtra from the Logic of Place and a Religious World-view, *Monumenta Nipponica*. 25(1/2), p.211.

What Nishida refers to as the dialectic of *soku hi* is what later thinkers from *Kyōto-gakuha* 京都学派 (Kyoto School), such as Keiji Nishitani 西谷 啓治 and Daisetsu Teitaro Suzuki 鈴木 大拙 貞太郎, would come to call the logic of *soku hi*.[98] Nishitani explains:

> a thing cannot be expressed simply in terms of its "being one thing or another." It is rather disclosed precisely as something that cannot be expressed. […] Should we be forced to put it into words all the same, we can only express it in terms of paradox, such as: "It is *not* this thing or that, therefore it *is* this thing or that."[99]

This is given a more formal structure by Suzuki, who famously writes: 'To say "A is A" is [t]o say "A is not A." Therefore, "A is A."'[100]

While such paradoxical and contradictory definitions can seem nonsensical, particularly for those from Western and Eurocentric traditions, Krummel explains that 'soku-hi […] connotes the conjunction or inseparability in "is and is-not" or "affirmation-yet-negation," the structural bi-conditionality or non-duality in their mutual reference and interdependence. It expresses the dialectical identity of absolute contradictories.'[101] In other words, the logic of *soku hi* is the unity of contradictories, where a thing both is what is and is what it is not. Thus understood, for Nishida, *soku hi* is the dialectical structure of reality, whereby and wherein a thing both is what it is and is what it is not.

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[98] Nicholaos John Jones (2004). The Logic of Soku in the Kyoto School, *Philosophy East & West.* 54(3), pp.302 – 321.

[99] Keiji Nishitani, and Jan Van Bragt, trans. (1982). *Religion and Nothingness*. Berkley and Los Angeles; University of California Press. p.124.

[100] Daisetsu Teitaro Suzuki, as citied by Michiko Yusa (2019). D. T. Suzuki and the "Logic of Sokuhi," or the "Logic of Prajñāpāramitā," In - Gereon Kopf, ed. (2019). *The Dao Companion to Japanese Buddhist Philosophy*. The Netherlands; Springer Netherlands. p.589.

[101] John W. M. Krummel (2015). *Nishida Kitarō's Chiasmatic Chorology: Place of Dialectic, Dialectic of Place*. Bloomington: Indiana University Press. p.125.

Let us stop for a moment and briefly consider a favourite example of Nishida's: life and death.[102] Life is not death; death is the absence of life. Conversely, death is not life; life is the absence of death. Thus, life and death are contradictories. Nevertheless, without life there would be no death, as death is the end of life. Equally, without death there would be no life, as life endures through death. Thus, life and death are contradictories, and yet both are unified. Potential oversimplifications aside, for Nishida life and death exemplify how contradictories are unified through the logic of *soku hi*.

We will return to this in Chapter 4, Section 1.2.3, as *soku hi* also highlights the congruent relation between reality and logic for Nishida, albeit it a quite different kind of correspondence to that advocated for in many Western traditions.

2.2 Soku hi and Kōiteki Chokkan

Stating that all of reality is structured in such a way is, to say the very least, a considerable claim to make, and one which Nishida spent the entirety of his life trying to articulate. The relevant point is that, in the context of *soku hi*, it is the contradiction between action and intuition that unifies them. Nishida explains that '[r]eality [...] is both subjective and objective, both *noema* and *noesis*. Subjectivity and objectivity are absolutely opposed, but reality is the unity of subjectivity and objectivity.'[103] Here Nishida's usage of the terms *noema* and *noesis* reflects a knowledge and rejection of Edmund Husserl's work, as he finds no such inherent duality between perceiver and perceived. This is because, for Nishida, in the world of *kōiteki chokkan* what we do and think are unified by their contradictory relationship with each other. Nishida further explains, stating that 'true reality stands in opposition to personal action, it too must determine personal action. True reality is the world which

[102] Nishida's example is likely inspired by the Buddhist 'Five Remembrances' of the *Upajjhatthana Sutta* (also known as *Abhiṇhapaccavekkhitabbaṭhānasutta*).
[103] Nishida (1970). *Religious Consciousness.* p.246.

includes personal action, or conversely, in which we act personally.'[104] Accordingly, action and intuition, individual and world, subject and object, all unified by their inherent contradiction.

Action is not intuition, as intuition arises from the activities of a world which 'both transcends and includes personal action.'[105] Intuition is not action, as action arises from the intuitions offered by the world that, once again, transcends and includes the individual. Nevertheless, without intuition there would be no action, and without action there would be no intuition. Action is not intuition, nor is intuition action. Yet, both are unified by their inherent contradiction, as well as by the contradiction between the individual and the world. Thus, for Nishida, *kōiteki* and *chokkan*, action and intuition, individual and world, all unified by their inherent contradiction.

2.3 Soku hi and Art

Soku hi also shows why art is a paradigm example of *kōiteki chokkan*, in the sense that art arises from the unity of artist and world even though, as Nishida explains, 'in artistic creativity the thing never becomes the self and vice versa.'[106] This contradiction then shapes what both is and can be created by an artist. This is what Nishida meant when he previously argued that 'in artistic intuition [t]hings beckon and move us. Things become the self and vice versa.'[107] Accordingly, we create art in and with the world, just as the world creates art in and with us. Krummel explains further:

> Nishida shows the dialectic [of *soku hi*] as unfolding not only internally, within the structure of one's inner experiences and cognition, but also externally, to manifest the

[104] Nishida (1970). *Fundamental Problems of Philosophy*. p.2.
[105] Ibid. p.20.
[106] Ibid. p.182
[107] Ibid. p.179.

> creative structure of the world's formations and the interactivity between individual selves that contributes to that creativity. [108]

In other words, we exist in a creative world which both includes and transcends our creative activities and intuitions, and it is the contradiction between that allows for the creation of art. Consequently, when an artist creates, this is a creative activity that belongs as much to the artist as it does to the world.

In the example of Dance, what is and can be performed is shaped by the contradiction between a Dancer and the material, biological and sociohistorical world in which they are situated. Ballet and *Noh*, as we saw, arise when Dancers allow the world to create through them by way of the actions and intuitions it offers. Without artistic activity there would be no artistic intuition. Without artistic intuition there would be no artistic activity. Yet, artistic activities are not artistic intuitions, and artistic intuitions are not artistic activities. Both are contradictories and, thus, unified.

2.4 Summary and Context

Soku hi and *kōiteki chokkan* show how what we do and think are unified by their inherent contradiction, both with each other and with the world. Action is not intuition. Intuition is not action. Yet, without intuition there would be no action, and without action there would be no intuition. Without a world that both transcends and includes the individual, there would be no action or intuition. The contradiction of *kōiteki* and *chokkan* is congruent with the contradiction of reality. Thus, the concept of *kōiteki chokkan*, and how it is unified by *soku hi,* offers insights about the unity of action, intuition, and world, thereby blurring the line between.

[108] Krummel (2015). *Nishida Kitarō's Chiasmatic Chorology*. p.80.

Art is a paradigm example of this, as, similar to Varela et al., who previously gave that 'cognition is […] the enactment of a world and a mind,'[109] art is the enactment of an artist and their art, as well as, more fundamentally, a world and an individual. In Chapter 4, Section 1.2.3, we will return to *soku hi*, as it will show why Nishida explicitly rejects the patina of *logical positivism* found on contemporary science, offering a new way of understanding the experiments and studies looking at entrainment to be discussed in Chapters 2 and 3. For Nishida, science cannot correspond with reality, as reality does not display the type of structure that can be corresponded with, at least, not in the way that contemporary science advocates.

On this topic, Noë will also have much to say in Chapter 4. Noë's so called *aesthetic paradigm*, alluded to in *Strange Tools* and articulated in *The Entanglement*, offers a middle way between *soku hi* and contemporary science, as it recognises that true knowledge involves both subjectivity and objectivity, to the extent that cultural norms and personal assessments shape scientific activities, as do scientific activities shape cultural norms and personal assessments. Nevertheless, for the moment, *soku hi* shows that the work of art for Nishida is ontological, as it is a creative activity that shapes the world which, in turn, shapes the creative activity, thus exemplifying the unity of action, intuition, and world.

Section 3: The *Work* of Art for Alva Noë

For Noë, the work of art is philosophical. It is an activity that aims to investigate, disrupt, and reorganise how we humans live. To explain, Noë gives that 'both art and philosophy—superficially so different—are really species of a common genus whose preoccupation is with the ways we are organized and with the possibility of reorganizing ourselves.'[110] While labelling artists as philosophers and philosophers as artists may be a

[109] Varela et al. (1991). *The Embodied Mind*. p.9.
[110] Noë (2015). *Strange Tools*. p.xiii

titillating idea to some, perhaps less so to others, Noë argues here that art is a philosophical practice, and that, equally, philosophy is an artistic practice. For Noë, such practices 'seek to bring out and exhibit, to disclose and illuminate, aspects of the way we find ourselves organized.'[111] In other words, artists investigate and aim to reorganise life.

It is important to note that Noë is not saying here that this is the sole purpose or function of art—a common criticism targeted at him, and one which he will be shown to defend at length in Section 5 of this chapter. For Noë art can have a myriad of overlapping functions and inspirations, be they practical, political, economic, or ethical. While important, for Noë, these functions are secondary to the primary function of art. This is because, as Noë explains, '[a]rt is not manufacture. Art is not performance. Art is not entertainment. Art is not beauty. Art is not pleasure. Art is not participation in the art world. And art is definitely not commerce. Art is philosophy. Art is putting our true nature on display before ourselves.'[112] What Noë is saying here is that what differentiates art from its many other functions is the way it puts life on display, thereby offering new and strange ways of organising ourselves.

3.1 The World of Organised Activity

Noë explains that '[o]ur lives are one big complex nesting of organized activities at different levels and scales. [...] We are always captured by structures of organization. This is our natural, indeed our biological, condition. It is the basic fact about us.'[113] Hence, for Noë, to be human is to be organised. It is to both organise and be organised by our activities. To act in a world which, in turn, acts on us. In this way, Noë's organised activities resonate with Nishida's claim that '[r]eality both transcends and includes personal action,'[114] as, for Noë,

[111] Noë (2015). *Strange Tools*. p.16
[112] Ibid. p.206.
[113] Ibid. p.10
[114] Nishida (1970). *Fundamental Problems of Philosophy*. p.20.

all of our lives are entangled in such structures,[115] and we are constantly caught up in the process of becoming entangled. They are the norms, practices, and values that bind us, offering a sense of belonging and, as will be shown in Chapter 4, Section 2.2., shape what we are. They are how we learn, how we communicate, and how we express our dynamic and unfolding identities. Thus, for Noë, organised activities include and transcend the individual, in the sense that they both organise and are organised by our individual activities.

In *Strange Tools*, Noë provides examples like breast-feeding, conversation, '[t]alking, walking, eating, perceiving, [and] driving,'[116] and later including dancing and music in 'Entanglement and Ecstasy in Dance, Music, and Philosophy,'[117] as well as writing, seeing, the creation of pictures in *The Entanglement*. What all these organised activities have in common is that they are, to borrow Nishida's terminology, something we do in and with the sociohistorical world.

Consider, for example, the organised activity of dancing, described by Noë in *Strange Tools* as 'a skillful activity that is taken up spontaneously and without explicit training by many people everywhere.'[118] When we dance, our activities are shaped by established norms and practices of dancing which, in turn, get shaped by our activities when we dance. In this way, dance and dancing resonate with each other, both shaping and being shaped by established norms and practices. Organised activities, like dancing, shape and limit what is and can be done by the individual, as they provide a structure of organisation which both include and transcend us. In other words, we organise a world that organises how we act. Our material, biological, and sociohistorical existence organises what we can and will do as

[115] Noë (2015). *Strange Tools*. p.10
[116] Ibid. p.10.
[117] Noë (2021). *Entanglement and Ecstasy in Dance*. pp.63 – 80.
[118] Ibid. p.64.

individuals which, in turn, organises our material, biological, and sociohistorical existence. Thus, for Noë, to be human is to both organise and be organised by our activities.

Consequently, much of what we can and will do is shaped by the organised activities in which we are entangled. Noë explains:

> these structures of organization are not of our own making. We don't direct or orchestrate or invent the dynamic patterns that organize us when we walk, look, listen, breast-feed, or talk. We are not exactly slaves to them—for our participation in such practices is, in many ways, precisely the exercise of our agency. […] But we are, or are at least liable to get, lost in the complex patterns of organization that make up our lives.[119]

This will be important for later discussions, as Noë's point here is that our individual activities are shaped by structures of organisation. From the top down, these organised activities shape individual activities, shaping what is and can be done. From the bottom up, individual activities shape organised activities, as the activity as a whole is shaped by its constituent parts. This is a kind of downward and upward organisation where parts and wholes are mutually shaped, thus exemplifying Gillett's upward and downward determination.[120] These organised activities are so complex and ubiquitous that we are likely unaware of the many ways in which our lives are entangled in them. They impose and sustain norms, as well as offer limitations and constraints on what we can and will do as individuals. Therefore, while '[w]e are not exactly slaves to them,'[121] as Noë previously gave, organised activities shape much of our lives, as well as, as we will see in Chapter 4, what we are.

[119] Noë (2015). *Strange Tools*. p.10
[120] Gillett (2016). *Reduction and Emergence*. p.201.
[121] Noë (2015). *Strange Tools*. p.10

3.2 Art as Liberation

For Noë, art offers liberation from organised activities. Noë explains that '[a]rtists do the miraculous: they refuse to play by rules, or rather, they invite you, with them, to make up the rules as you go along.'[122] As such, artists are not shackled by the limitations, constraints, and rules provided by organised activities. In fact, it is precisely these shackles that the artist aims to investigate and remove. They do this by creating works of art that, as Noë previously noted, 'disclose and illuminate […] aspects of the way we find ourselves organized.'[123] In other words, artists put organised activities on display, showing what they are and, crucially, what they can be. Thus, art is an activity that seeks to investigate and reorganise life.

This is why Noë calls art a strange tool, as artists 'make art out of organized activities.'[124] Art is strange because, by design, it appears odd at first, in the sense that it stops us in our tracks and invites us to engage with something new. At its best, art disturbs or disrupts, breaking us free from the norms, limitations, and constraints on what we can and will do as individuals. In so doing, art offers new and previously unrecognised ways of organisation. Art is a tool because its strangeness allows us, both as individuals and as a collective, to actively investigate and reorganise how we live. Therefore, for Noë, art is a strange tool because, by design, we can use its novelty to reevaluate and reorganise aspects of the organised activities in which we are entangled.

Without art, our lives would be stagnant and unchanging. Art breaks conventions, offering new and strange ways of organisation which shape culture and society. Art, in other words, offers us the tools for our emancipation from the organised activities in which we are entangled. This means that, for Noë, art is not something merely produced or experienced as a created work, but something that also actively works to alter and reorganise our lives.

[122] Noë (2015). *Strange Tools.* p.75
[123] Ibid. p.16
[124] Ibid. p.10

It should also be noted that when Noë describes art as a strange tool, he does so in the sense that the art, like philosophy, is an activity that investigates and disrupts organised activities. Art is a "tool" that society and culture uses to liberate itself from the structures of organisation that shape and organise our lives. Where organised activities limit what is and can be conceivably done, art allows us to break free from our perceived norms and practices. Consequently, art is a driving force for society and culture. However, to be discussed at the end of Section 6.2 of this chapter, Nishida discuss tools in very different way. Rather than using the word "tool" metaphorically, Nishida is interested in literal tool-making and tool-use, and how this shapes the world that shapes us.

Nevertheless, like Nishida, for Noë art and life are entangled in a complex and mutual relationship. What the artist creates shapes the world which, in turn, shapes what the artist creates. For him, what the artist creates is informed by the organised activity that they aim to alter. This reciprocity is what Noë, borrowing from Ian Hacking,[125] calls 'the looping entanglement of art and life.'[126] On one side of this relationship, art is informed by life. What is created by an artist is informed by the organised activities they seek to alter. On the other side of this relationship, life is altered by art. Organised activities are shaped and reorganised by the strangeness of art. Without life, there would be no inspiration for art. Without art, life would be stagnant and unchanging. In other words, life is the impetus for art and art, in turn, is a catalyst for life. While distinct, art and life shape one another. The key difference in this relationship is that the artist stands partially removed from the organised activities they aim to investigate and reorganise. It is only by being free from these constraints that art can offer emancipation from the conformity of life, thus allowing us to discover new structures of

[125] Ian Hacking (1995). The Looping Effects of Human Kinds, In - Dan Sperber, David Premack, and Ann James Premack (1996;2012). *Causal Cognition: A Multidisciplinary Debate*. United Kingdom; Oxford University Press. Chp.12. See also - Ian Hacking (1999). *The Social Construction of What?* Harvard University Press.
[126] Noë (2021). *Entanglement and Ecstasy in Dance*. p.63.

organisation. Therefore, in Noë's 'looping entanglement of art and life,'[127] life informs art and art alters life.

3.3 The Art of Dance

Consider, once again, the example of Dance. For Noë, Dance is a creative activity that seeks to alter the organised activity of dancing from which it is informed. Noë explains that '[w]hat makes dancing dancing is the way it is embedded in our lives, in particular, the way, by virtue of its embedding, it organizes us. What makes the artist's dancing something other than dancing is the bald fact that it refuses to be embedded in that sort of way.'[128] Dance, in other words, is a creative activity which is freed from the organised activity of dancing. It is only from this vantage point that it can investigate and potentially reorganise what dancing is. Think of how, for example, John Travolta's choreographed disco moves in *Saturday Night Fever*,[129] or the moonwalk made famous by Michael Jackson, have become embedded in the organised activity of dancing, with people everywhere today intentionally or spontaneously incorporating these iconic movements into their own dancing.

Although categorically distinct, dancing and Dance—along with organised activities and art—are entangled, this being the central thesis of *The Entanglement*, Noë's follow-up book to *Strange Tools*, wherein he explains that '[d]ancing gives rise to Dance, the art of dance, which in turn gives dancing new resources, and this circular, generative recursion drives us forward,'[130] and later adding that 'it is not possible, for you or me or anyone else, to dance in a way that is unaffected by the influence of Dance and its history.'[131] Accordingly, dancing informs the creation of Dance, and Dance alters dancing. Therefore, Dance is 'the

[127] Noë (2021). *Entanglement and Ecstasy in Dance*. p.63.
[128] Ibid. p.71.
[129] John Badham , dir. (1977). *Saturday Night Fever*. United States; Paramount Pictures.
[130] Noë (2023) *The Entanglement*. p.32.
[131] Ibid. p.68.

enactment of a world and a mind,'[132] in the sense that what the artist creates is informed by the world organised activities which, in turn, is altered by what the artist creates.

How then can the artist break free from the organised activities that we all find ourselves part of? Do artists have some magical or godly abilities inaccessible the rest of us? Not at all. Artists are simply those who have, as Noë explains, 'an entirely different kind of relationship to [organised activities] than we ordinarily have.'[133] Where organised activities shape what we can and will be done by individuals within, it is '[a]rtists [who] refuse to play by rules, or rather, they invite you, with them, to make up the rules as you go along.'[134] This means that the relationship artists have with an organised activity is very different from those within, as it is only from the outside that an artist can investigate and potentially reorganise that from which they are informed.

In the example of Dance, artists are those who have such a relationship with the organised activity of dancing. The creation of Dance requires deliberation, planning, training, and knowledge of the organised activity of dancing itself. In this way, Noë considers Dance to be kind of '*meta-dancing*'[135] which investigates, disrupts, and alters the organised activity of dancing. To explain, Noë returns to his claim that true work of art is philosophical:

> philosophy does to our thought and talk what choreography [i.e., Dance] does to dancing. In effect, it shuts it up, or stops it, or interrupts it, it takes these earnest doings—talking, dancing, arguing—and samples them, looks at them sideways, brackets them, [and] "reorients us" to them. And philosophical reorientations, like

[132] Varela et al. (1991). *The Embodied Mind.* p.9.
[133] Noë (2021). *Entanglement and Ecstasy in Dance*. p.65. Emphasis removed.
[134] Noë (2017). *Strange Tools*. p.75
[135] Noë (2021). *Entanglement and Ecstasy in Dance*. p.66.

> choreographic ones, […] change the way we think, or dance, going forward. They change what we are.[136]

This is not to say that the Dance artist has access to some otherworldly ability, only that they seek to investigate and alter dancing. It is only then that Dance can free us from the norms and practices associated with dancing.

The relationship artists have with organised activities is not in any way unique or special. Each of us can, and often do, reflect upon our lives and how we are organised. We can all investigate, disrupt, and potentially reorganise how we live. As Noë notes, 'our participation in such practices is, in many ways, precisely the exercise of our agency. It's how we make friends, find mates, get from point A to point B, recognize people in the crowd.'[137] This means that we are all participants in organised activities, often willingly, and that we can all reflect upon and attempt to reorganise ourselves at any time of our choosing. In this way, we are all potential artists. Just as a child pestering a parent by constantly asking: "why" is practicing philosophy, whenever we attempt to create something that disrupts and alters organised activities we are practicing art. While, in art and philosophy, some are clearly more apt at this than others, both are something we can all achieve. Therefore, in Noë's 'looping entanglement of art and life,'[138] art offers us the means to free ourselves from the self-imposed shackles of organised activity.

3.4 Summary and Context

We can now parse out the details of Noë's conceptual framework so as to facilitate a dialogue with Nishida. Firstly, for Noë, to be human is to both organise and be organised. We act in a world that shapes how we act, in the sense that organised activities both include and transcend our individual activities. It is our shared material, biological, and sociohistorical

[136] Noë (2021). *Entanglement and Ecstasy in Dance*. p.68.
[137] Noë (2015). *Strange Tools*. p.10
[138] Noë (2021). *Entanglement and Ecstasy in Dance*. p.63.

existence that shapes and organises much of what we can conceivably do, meaning that organised activities dominate, or at least shape, much of our lives.

Secondly, for Noë, art offers liberation from the organised activities that shape our lives. Those that, as Noë put it, 'make art out of organized activities'[139] expose what they are and, crucially, what they can be. In so doing, art provides strange tools which we can use to reorganise ourselves, as well as break free from the many different and overlapping organised activities that dominate us. Without art, society, culture, and life would be stagnant and unchanging. Therefore, for Noë, the true work of art is to reorganise organised activities.

Thirdly, for Noë, there is a reciprocity between art and life. Art is not life, and yet life informs art. Life is not art, and yet art can alter life. Resonating with the concept of *soku hi*, as will be shown in Chapter 4, Sections 1 and 2, art and life are different yet unified. This is Noë's 'looping entanglement of art and life,'[140] wherein what the artist creates shapes our organised activities which, in turn, shape what the artist creates. Thus, Noë's understanding of art offers insights about the reciprocity between individual and organised activities, as well as between action, cognition, and the world. For him, art is the enactment of organised activities and an artist, of a creator and what is created, and, more fundamentally, a world and an individual.

However, like Nishida, Noë does not elucidate the exact mechanisms underlying the entanglement of art and life, or how this process shapes the world that shapes us. While, as the following three sections of this chapter will show, Nishida and Noë can provide a framework for investigating how actions and intuitions organise a world which, in turn, organises actions and intuitions, neither explains how exactly this takes place. This will be rectified in Chapters 2 and 3, and further expanded upon in Chapter 4, with the phenomenon

[139] Noë (2015). *Strange Tools*. p.10
[140] Noë (2021). *Entanglement and Ecstasy in Dance*. p.63.

of entrainment providing a concrete mechanism that demonstrates how life and art are entangled, and how this entanglement shapes what we are.

Section 4: Comparative Analysis

For Nishida and Noë, we live in a world of action and organisation. We act and are acted upon, organise and get organised, by a world that both transcends and includes our actions and intuitions. This is what Nishida means when he wrote that 'true reality […] both transcends and includes personal action,' [141] and what Noë means when wrote that '[w]e are always captured by structures of organization.'[142] It can thus be said that Nishida's world of *kōiteki chokkan* is comparable to Noë's world of organised activities, as both authors argue that what we do and think are inextricably entangled in and, crucially, with the world. This is Nishida and Noë's world of action and organisation.

4.1 The Sociohistorical, Biological, and Material World

Nishida and Noë emphasise different aspects of our shared reality. While both agree that we exist in an active would that includes individual action, each places a different emphasis regarding our shared sociohistorical, biological, and material existence. Noë does recognise the material and biological aspects of the world, writing that '[i]t is not a requirement that organized activities be social. Sometimes the environment itself organises us,'[143] later giving that 'organization […] is our natural, indeed our biological, condition,'[144] he is primarily interested in the sociohistorical world, as evident by the subtitle of *Strange Tools*: *Art and Human Nature*.[145] This is not to suggest that art has no link to the biological or material world for Noë. Using the example of Dance, he repeatedly asserts the opposite,

[141] Nishida (1970). *Fundamental Problems of Philosophy*. p.20.
[142] Noë (2015). *Strange Tools*. p.10
[143] Ibid. p.8.
[144] Ibid. p.10
[145] Ibid. Title.

explicitly stating that art and biology are inextricably tied together.[146] It is to say, however, that Noë is primarily interested in how art functions to reorganise life, society, and culture in the sociohistorical world.

In contrast, Nishida's understanding of the world is much more expansive than Noë's. While Nishida does offer a similar recognition to Noë's, specifically when he says that '[i]n social action, we structure society through action. We are determined by being born in society and living in society,'[147] and that 'we do not create things merely for the sake of the things. We create them for the sake of human life,'[148] Nishida also explains how

> [t]he world which is social […] is metaphysical and historical. This means that the world of truly concrete reality is social in essence and determines itself historically. Even the natural world can be conceived in the ultimate point of the subjective aspect of such determination.[149]

Nishida is saying here that the social world shapes personal action, and vice versa, as does the historical, biological, and material world. In fact, as Krummel previously explained, for Nishida there is only one world or reality, containing material, biological, social, and historical standpoints or perspectives.[150] Therefore, for Nishida, and Noë would expectedly agree, creator and created are 'not only physical and biological, but a social and historical entity.[151]

Nishida's tripartite reality is grounded in the Ancient Chinese, and later Japanese, *Principle of Three* which, as Robert E. Carter explains, 'divides the universe into three realms

[146] See, Noë (2015). *Strange Tools*. pp.15 – 17
[147] Nishida (1970). *Fundamental Problems of Philosophy*. p.69.
[148] Ibid. p.128.
[149] Ibid. p.36.
[150] Krummel (2012). *Basho, World, and Dialectics*. p.31.
[151] Nishida (1970). *Fundamental Problems of Philosophy*. p.121.

which, in their depth, are at the same time one.'[152] Accordingly, when Nishida says that 'truly concrete reality is social in essence,[153] he means that the sociohistorical world, the world of human beings, is where the material and biological worlds overlap. From this standpoint, the artist creates art, shaping the material, biological, and sociohistorical world which, in turn, shapes what the artist creates.

4.2 The Role of the Artist for Noë

However, Nishida and Noë disagree about the role of the artist. For Noë, the true work of the artist is done prior to the created work being offered to the world. This is when an artist makes art out of organised activities in order to display what they are and, crucially, what they can be. Implicit in this is the claim that the true work of art, being the investigation of life, is the work of a pre-existing artist prior to it being experienced by others. Thus, for Noë, 'the work *the art itself* achieves'[154] is secondary to the creative process of a preexisting artist.

This is exemplified by the fact that, when discussing the art of dancing, Noë often uses the words "Dance" and "choreography" synonymously. What is choreography if not the process of creating a choreographed work? Choreography is an activity prior to a creation. While there are different choreographic techniques, both planned and improvised, choreography is the work of a choreographer. Generally speaking, planned choreography is when rhythmic movements are explicitly dictated prior to a Dancer's performance, whereas improvised choreography is when Dancers are given general guidelines and prompts, once again prior to their performance.[155] In both styles, choreographers work with Dancers to create a work of art that can be displayed at some future time and place. Therefore, for Noë,

[152] Robert E. Carter (2008). *The Japanese Arts and Self-cultivation*. New York; State University of New York Press. p.111.
[153] Nishida (1970). *Fundamental Problems of Philosophy*. p.36.
[154] Noë (2015). *Strange Tools*. p.167
[155] For examples of how these techniques are taught, see – Lauren Kearns (2017). Dance Critique as Signature Pedagogy, *Arts and Humanities in Higher Education.* 16(3), pp.266 – 276.

the true work of choreography is done prior to being displayed, with the created work then (and only then) working to reorganise life.

Maraldo, when looking at how Nishida's concept of "*kōiteki chokkan*" is exemplified in art, deems understandings such as Noë's

> the usual view [where] the creative impulse begins in the individual's mind and ends in a work perceptible by others […]. Whether the aesthetics interprets the particular work as the embodiment and therefore the revelation of the artist's intention, or as a cultural product whose meaning is ascertained only by outside observers and participants, the work as a work of art is the creation of human subjectivity.[156]

While Maraldo's assessment is not directed at Noë, it is applicable. This is because Noë's strange tools are evidently the creation of human subjectivity, as it is only from the outside of an organised activity, which is to say, from the subjectivity of the artist, that they can create something completely new. While, of course, there must also be a preexisting organised activity from which the artist makes art out of, the ability to do so comes from the fact that, for Noë, the artist has the ability to create something new. This is why Noë considers choreography or Dance to be a kind of '*meta-dancing*,'[157] as what the artist creates is, by design, something new and subjective. Therefore, for Noë, art is the subjective creation of an artist, with the created work then (and only then) working to reorganise life.

4.3 The Role of the Artist for Nishida

Nishida disagrees. For him, the work of the artist does not end upon the creation of art, nor does it begin with a preexisting artist. This is because the true work of art, that is, what art does, is achieved by an artist in and with the world. Art is as much an offering from an artist to the world as it is an offering from the world to the artist. Art is the enactment of a

[156] Maraldo (2017). *Japanese Philosophy in the Making*. p.209.
[157] Noë (2021). *Entanglement and Ecstasy in Dance*. p.66.

mind and a world. This is the core insight of *kōiteki chokkan* and *soku hi*. An artist's actions and intuitions shape the world which, in turn, shapes their actions and intuitions.

This is why Nishida explains that '[t]he motive of our actions does not merely arise from within [nor] merely given from without either,' [158] and that 'intuition appears through our action, but at the same time it determines our action.'[159] Specific to art, this means that the true work of both art and artist does not end once an object, activity, or performance has been displayed for others to see, but continues on. While Noë might be amenable to this idea, given the unfolding reciprocity between organised activities and those caught up within, for him, this is secondary to the work of the artist. Nishida, in contrast, explains that 'we create things externally and […] things create us.'[160] In other words, the artist creates in and with a world that creates in and with the artist.

In contrast to Noë's understanding, for Nishida, an artist and world are mutually shaped by the creative process, and this reciprocity unfolds and persists through the created work. This is because, once again, 'the world is a creative process. And our body is a creative element of that world.'[161] As such, for Nishida, art's ability to shape the world is not secondary, nor is the artist's. Maraldo explains that

> Nishida envisions the artist not as an entity who simply preexists the creation of the artwork, but as someone who intuits the world by transforming it—a process that creates not only a work but the artist and a newly emergent world as well. Artist and work form mutually and are reflected in one another.[162]

[158] Nishida (1970). *Fundamental Problems of Philosophy*. p.193.
[159] Ibid. p.173.
[160] Ibid. p.182.
[161] Nishida (1937). *The Historical Body*. p.48.
[162] Maraldo (2017). *Japanese Philosophy in the Making*. p.209.

Kyle Peters, when applying *kōiteki chokkan* to questions regarding the role of authors, further adds that, for Nishida, 'artistic agency is decentered across manifold positions in artistic production, and thus that artistic production is diffused across the continuum of subjectivity and objectivity.'[163] In other words, art is not merely the creation of human subjectivity for Nishida. Nor is art merely the creation of the objective world. Art is the creative activity of an objective world that both includes and transcends human subjectivity. Thus, when it comes to the role of the artist, Nishida is more of an enactivist than Noë, as he argues that art is 'the enactment of a world and a mind.'[164]

Nishida would then, expectedly, disagree with Noë's assertion that Dance is a kind of meta-dancing. It is not that choreographers can create in relative isolation from the world, but that the world allows for the creation of art. Nishida writes, '[i]t is not that artistic ideas come from heaven; they rather emerge from this great earth.'[165] Art is something the world offers the artist who, in turn, offers art to the world. So, while Nishida appears to be open to the idea that art can alter and shape life, it does this both in and with the world. Therefore, for Nishida, art is not merely the creation of an artist that then works to reorganise life, but rather the creative activity of the world that both includes and transcends the artist, and which unfolds and persists through their created work.

4.4 Summary and Context

Nishida and Noë both agree that we live in a world of action and organisation, wherein what we can and will do is shaped by a world that both includes and transcends the individual. While Noë is primarily interested in the sociohistorical world, he implicitly agrees

[163] Kyle Peters (2018). Artistic Production and the Making of the Artist: Applying Nishida Kitarō to Discussions of Authorship, *Philosophy East & West*. 68(2), p.477.
[164] Varela et al. (1991). *The Embodied Mind*. p.9.
[165] Nishida (1970). *Fundamental Problems of Philosophy*. p.182

with Nishida's expanded understanding of how we both act in and are acted upon by the material and biological worlds.

However, Nishida and Noë disagree about the role of the artist. For Nishida, art is not merely the creation of an artist that then (and only then) works to reorganise life, as suggested by Noë, but rather the creative activity of an active world that both includes and transcends all human activity. Additionally, for Noë, the work of art, that is, what art does, is secondary to the work of the artist, in the sense that art is a creation of a preexisting artist who is informed by preexisting organised activities. Conversely, for Nishida, the work of both art and artist unfolds and persists through the created work, as what the artist creates both shapes and is shaped by the world.

Therefore, Nishida and Noë agree that we live and create art in a world of action and organisation, and that much of what we can and will create is shaped by a world that both transcends and includes our actions, intuitions, and thoughts. Although, both disagree about the role of the artist therein, with Nishida having more of an enactivist understanding than Noë.

Nevertheless, it remains that neither Nishida nor Noë elucidates the mechanisms underlying the world of action and organisation, or how we shape the world that also shapes us. While this dissertation strongly endorses their shared perspective, there is still a need for a more grounded discussion in the next two chapters, wherein entrainment will be offered as a mechanism that organises the world that organises us, organising and shaping, as we will see in Chapter 4, what we are.

Section 5: Criticisms of Noë

Since its publication, *Strange Tools* has received several critiques, many of which Noë has responded to.[166] For example, Carrie Noland,[167] Nancy S. Struever,[168] and Thomas Rickert[169] individually express a need for further clarification. Similarly, Noël Carroll,[170] Anne W. Eaton,[171] and Paul Guyer[172] all argue that, as we will see, Noë's understanding of art is too limited, and that he fails to account for the diversity and complexity of the world. This is because—and Noë largely agrees—the experiential or phenomenal aspects of art are much more complex than the organised activities they aim to alter. Noë states as much in *Strange Tools*, explaining that '[a]udiences and makers engage with each other through the opportunities that artists manufacture. We enact art as much as we perceive it,'[173] and later conceding in 'Entanglement and Ecstasy in Dance' that:

> Experience is an aesthetic problem. Perhaps […] *the* aesthetic problem. And crucially, it is a problem that art itself takes on. For works of art are both objects to experience and opportunities for us to catch ourselves in the act of experiencing. Art engages human experience. Art works with human experience. Art changes human experience.[174]

[166] Alva Noë (2017). Art and Entanglement in Strange Tools: Reply to Noël Carroll, Anne Weaton and Paul Guyer, *Wiley*. 98, pp.238 – 240; and Noë (2021). *Entanglement and Ecstasy in Dance*.
[167] Carrie Noland (2021). Choreography as Breakdown: Alva Noë and Dance, *Philosophy & Rhetoric*. 54(1), pp.45 – 62.
[168] Nancy S. Struever (2020). "Not Theory, Thought": Collingwood's Early Work on Art, *Philosophy & Rhetoric*. 53(1), pp.21 – 33.
[169] Thomas Rickert (2021). Making Movies with Song: Movement, Style, and the Invitations of Music, *Philosophy & Rhetoric*. 54(1), pp.28 – 44.
[170] Noël Carroll (2017). Comments on Strange Tools by Alva Noë, *Wiley*. 94(1), p.218.
[171] Anne W. Eaton (2017). Strange Tools vs. Plain Tools?: Comments on Alva Noë, *Wiley*. XCIV(1), p.227.
[172] Paul Guyer (2017). Alva Noë, Strange Tools: Art and Human Nature, *Wiley*. XCIV(1), p.230.
[173] Noë (2015). *Strange Tools*. p.137.
[174] Noë (2021). *Entanglement and Ecstasy in Dance*. p.73.

Here Noë acknowledges that art has a phenomenal and experiential component, and that this requires further exploration and clarification. In fact, this is one of the main topics of his subsequent book, *The Entanglement*.

While essential reading for those interested in the development and evolution of Noë's philosophy, the critique that the experiential or phenomenal aspects of art are much more complex than the organised activities they aim to alter has been well covered in Noë's two response papers, as well as in his subsequent book. Therefore, to avoid repetition, it will be beneficial to look at two critiques which, at the time of writing, Noë has not yet responded to: (1) art can have many functions other than those Noë describes, and (2) art can affirm the way humans are organised.

These criticisms will be important to this discussion because they will further develop where Nishida and Noë agree, exemplified by how they can both respond to each other's critiques. They will also show how Nishida can offer a more expanded understanding of art that recognises it as both a strange and ordinary tool. This creates a more robust theory of art, while also setting the stage for the following discussion on the entanglement of art, life, and entrainment.

5.1 Noël Carroll

In 'Comments on Strange Tools by Alva Noë,' Carroll suggests that Noë 'assigns too narrow a role to art, one that accords poorly with its history.'[175] While amenable to the idea that art can work in the way that Noë describes,[176] Carroll argues that this is only one of many functions art has had throughout history. Borrowing Noë's example, Carroll explains that,

[175] Carroll (2017). *Comments on Strange Tools*. p.218.
[176] Ibid. p.217 – 218.

> throughout history, [Dance] has been composed to perform works other than displaying for scrutiny our dancing selves or even our moving selves. There have been war dances, anti-war dances, trance dances, victory dances, rain dances, dances in the service of rituals of all sorts, commemorative dances, celebratory dances and so forth. Many of these could not perform their designated function, if they were in the business of displaying movement for close scrutiny.[177]

Carroll's point here is that Dance can have other functions, many of which, he believes, could not be achieved if the artist aimed only 'to bring out and exhibit, to disclose and illuminate, aspects of the way we find ourselves organized'[178] in the way that Noë describes. Therefore, for Carroll, Noë's description of art is too narrow, especially when considering the diverse historical functions of art, such as ritual dances. While open to Noë's description of art as a tool, Carroll's critique is that it is not necessarily a strange one.

5.2 Anne W. Eaton

In 'Strange Tools vs. Plain Tools?: Comments on Alva Noë,' Eaton has a similar critique, stating that we should be 'dubious of any theory that purports to describe *all* art, from Paleolithic times to the present, capturing all traditions from all continents.'[179] While also open to the idea that art can disrupt and alter organised activities in the way Noë describes,[180] Eaton thinks that Noë's understanding of art is too limited in scope. When Noë states that he is interested in 'the work *the art itself* achieves,'[181] Eaton thinks that such assertions imply that art has *a* function, and this function is its defining feature, or possibly its *telos*.

[177] Carroll (2017). *Comments on Strange Tools*. p.217.
[178] Noë (2015). *Strange Tools.* p.16
[179] Eaton (2017). *Strange Tools vs. Plain Tools?* p.227.
[180] Ibid. p.227.
[181] Noë (2015). *Strange Tools*. p.167

Eaton argues that Noë holds a mistaken distinction between those creations with a practical or plain function and those creations with an artistic or strange function.[182] To explain, Eaton gives that 'many of the world's great nonEuropean artworks—from Cherokee baskets to Nkondi sculpture of the Congo region to Maori kahu kuri (cloaks) to Persian enamel—have been made for and served […] practical works.'[183] So, while art can function in the way Noë suggests, Eaton argues that it often serves a plain or ordinary function too. Not recognising this fact, Eaton contends, supports historic dichotomies between arts and crafts, many of which '[f]eminist artists and art historians […] have long been critical of […] because artifacts traditionally produced by women almost always end up in the "craft" category.'[184] Accordingly, the work of art is not necessarily to investigate and disrupt an organised activity, as art can also have a plain or ordinary function. Therefore, for Eaton, Noë's understanding of art excludes practical or plain forms of art, as well as potentially reinforcing problematic distinctions between "arts" and "crafts." While open to Noë's description of art as a tool, Eaton agrees with Carroll that art is not necessarily a strange tool.

5.3 Paul Guyer

In 'Alva Noë, Strange Tools: Art and Human Nature,' Guyer offers a similar criticism, explaining that

> [s]ometimes [art] will be engaging because it is disruptive, sometimes because it is insightful, but sometimes it may be engaging without being either disruptive or insightful, and I do not think it is right to say that only in the former cases but not in the latter do we have art.[185]

[182] Eaton (2017). *Strange Tools vs. Plain Tools?* pp.227 – 229.
[183] Ibid. p.227.
[184] Ibid. p.228.
[185] Guyer (2017). *Alva Noë, Strange Tools.* p.230.

This gets right to the core of Noë's position, as Guyer shows here that what makes art art for Noë is how it disrupts and reorganises life. While also open to the idea that art can function in such a way,[186] for Guyer this is just one of the many functions that art has in our lives.

While art can iterate and build upon what has come before, Guyer adds that 'innovation or novelty are hardly always disruption.'[187] Guyer is correct, as we can create and appreciate works of art that do not challenge and disrupt, as can we create and appreciate works of art that affirm or maintain the organised activities from which they are informed. Therefore, Guyer's critique highlights that art does not always need to be disruptive or insightful, as Noë suggests, as it can also affirm or maintain established ideas. While also open to Noë's description of art, Guyer agrees with Eaton and Carroll that art is not necessarily a strange tool.

5.4 Art as an Ordinary Tool

Many examples of how art is not necessarily a strange tool can be found in traditional Japanese arts. The samurai code of *bushidō*, the different fighting styles of *aikidō* and *jūdō*, the tea ceremonies of *sadō*, and the calligraphy of *shodō*—of which Nishida was a practitioner—are all forms of art that do not, as Noë argues, 'seek to bring out and exhibit, to disclose and illuminate, aspects of the way we find ourselves organized.'[188] On the contrary, they are intended to display life and its place within the wider world and cosmos, as well as offering a path for self-cultivation.[189] These forms of art do not seek to disrupt and reorganise life.

Consider *ikebana* 生け花, the Japanese art of flower arrangement, also known as *kadō*. Practitioners of *ikebana*, masters known as *kadōka* 華道家, create flower arrangements

[186] See, Guyer (2017). Alva Noë, Strange Tools. p.231.
[187] Ibid. p.236.
[188] Noë (2015). *Strange Tools*. p.16
[189] Carter (2008). *The Japanese Arts and Self-cultivation*. p.111.

designed to harmonise with their surroundings, offering a unified and congruent display of reality. Typically, this is done by creating minimalistic, asymmetrical, and harmonious arrangements. *Kadōka* also take into consideration the shape and line of flowers and stems, the type of vase, the amount and visibility of water, the surrounding decor, as well *ma* 間 (negative space) which is equally as important. The minimalistic and asymmetrical designs of *ikebana* arrangements are not merely aesthetic choices; they are deeply entwined with the philosophical tradition and cultural values of the *kadōka*.

In *The Japanese Arts and Self-Cultivation,* Carter explains that *ikebana* is grounded in the *Principle of Three* which, just like Nishida's tripartite reality, 'divides the universe into three realms which, in their depth, are at the same time one.'[190] It is both with and within these realms that the *kadōka* create arrangements that are meant to represent reality. *Ikebana*, Carter explains, 'is a depiction of the order of the cosmos, and this order is repeated in the inner nature of a human being: the microcosm imitates the macrocosm. The longest stem, or branch, represents heaven, the shortest earth, and the stem or branch of intermediate length represents human beings.'[191] This means that, borrowing Noë's terminology, 'the work *the art itself* achieves'[192] in *ikebana* is not a disruption and reorganisation of life, but a congruent instantiation of life and its place within the wider cosmos. Thus, when creating *ikebana*, Carter explains that the *kadōka* 'must learn to flow with nature and its laws, rather than strive to overcome them, to conquer nature.'[193]

This is what Nishida means when he explains in *An Inquiry into the Good* that '[w]hen one sees a flower, the self has become the flower. To investigate a flower and elucidate its basic nature means to discard all of the self 's subjective conjectures and thereby

[190] Carter (2008). *The Japanese Arts and Self-cultivation*. p.111.
[191] Ibid. p.111.
[192] Noë (2015). *Strange Tools*. p.167
[193] Carter (2008). *The Japanese Arts and Self-cultivation*. p.111.

unite with the basic nature of the flower.'[194] In creation, *kadōka* become their arrangements, in the sense that the artistic actions and intuitions are cultivated and unified in and with the world. This cultivation is due to the fact that *ikebana* is communicative, with different arrangements and flowers evoking different meanings. *Suisen* 水仙 (daffodils) are thought to evoke respect, *burūberu* ブルーベル (bluebells) evoke gratitude, *shirayuri* 白百合 (white lilies) evoke purity, and so on. This is the *hanakotoba* 花言葉 (language of flowers), and how the actions of the *kadōka* in and with the world cultivate intuitions which, in turn, cultivate the actions of the *kadōka*.

Ikebana is also an invitation. It invites the self-cultivation of the *kadōka* and of the viewer. The *kadōka* invite you to join them in the creative processes of the world, as *hanakotoba* cultivates an awareness of reality and our place within. When engaging with *ikebana*, 'the flower arrangement itself is an expression of and a pointer to the developing profundity of the psychological, spiritual, aesthetic, and ethical self-development of the artist-practitioner.'[195] It is this self-cultivation of the artist, both in and with the world, that gets communicated. It displays the underlying unity of the world, instantiating how, as Carter explains, 'the truth of things can be found in a flower, […] for all things are revelations, self-manifestations of the universal originating creative energy.'[196] Put another way, *ikebana* cultivates the appropriate mindset and approach to navigating ones life, engaging in spiritual practices aimed at personal growth, and adhering to moral principles that guide interactions with others, our environment, and the universe as a whole. Thus, *ikebana* invites the self-cultivation of all.

Hence, the work that *ikebana* achieves is not necessarily disruptive or strange. While *ikebana* may function as Noë describes, offering creations that can redefine what flower

[194] Nishida (1990). *An Inquiry into the Good*. p.77.
[195] Carter (2008). *The Japanese Arts and Self-cultivation*. pp.99 – 100.
[196] Ibid. p.98.

arrangement is and can be, this is not its defining feature. The true work of *ikebana* is self-cultivation. It involves the self-cultivation of the *kadōka* as they create both in and with the world. It also evokes self-cultivation in those who view the created work, manifesting harmony with the world.

This is the *way*, or *dō* 道 (a transliteration of Chinese "*dao*"), of flowers, as well as the *way* of *kadō* and the *kadōka*, much like *bushidō*, *aikidō*, *jūdō*, *shodō*, and *sadō*. Traditional Japanese arts, such as *ikebana*, exemplify how art can function as an affirmation of life, while also providing means for self-cultivation. This supports the idea that art can be a plain, everyday, and ordinary tool, contrary to Noë's description.

5.5 Summary and Context

In summary, Carroll, Eaton, and Guyer's criticisms of Noë are twofold. Firstly, art has many different functions, some of which could not be achieved if artists were solely preoccupied with investigating and displaying organised activities in the way described by Noë. Secondly, art is not necessarily a strange too; it can also affirm the organised activities from which it is informed. As the previous examples have shown, art can also be an ordinary tool. Thus, the critiques of Noë can be summarised as follows: 1. Art has many functions, and 2. Art can also be an ordinary tool.

Section 6: Rejoinders

Now that we have explained the two critiques, let is now see how Noë and Nishida might respond. The first criticism, being that art has many functions, is one which Noë would agree with. Using his favourite example, Noë explains that '[d]ancing is by no means the *only* source of material for Dance, and [his] discussion so far, insofar as it has tended to suggest a one-one correspondence between Dance art and dancing, has been an oversimplification.'[197]

[197] Noë (2021). *Entanglement and Ecstasy in Dance*. p.72.

Noë recognises here that Dance and dancing, and by extension art and organised activities, can be informed by a myriad of other influences, having many different and overlapping functions in our lives.

Noë further explains that artists create with 'more widely available raw materials of movement, expressive gesture and work with such themes as love, or identity, or politics, or feeling, need, trauma.'[198] Hence, when Carroll rightly pointed out that art has been created throughout history for many other reasons than the investigation of life,[199] Noë would expectedly agree. Similarly, Noë would also agree with Eaton's criticism that art throughout the world has often served a practical function, as Noë explicitly states that '[a]rts seem to participate in crafts and technologies. They are tied to the manual and the constructive. Even performing arts—like music and dance—are bound up in the practical.'[200] Therefore, the first criticism directed at Noë is a moot point, as he largely agrees that art can have many different functions.

6.1 The Limits of Noë's Position

The second criticism, being that art is not necessarily a strange tool, is not so easily dismissed. This is because art can be quite ordinary, reflecting the organised activities from which it is informed. Carroll showed this by highlighting how, historically, there have been many forms of dance, some of which would fail to carry out their intended functions if artists were preoccupied with investigating, displaying, and disrupting organised activities in the way that Noë describes. Similarly, Eaton argues that non-European art often has a practical function. Combined, Carroll and Eaton argue that art can have different functions, and that many of these could not function properly if artists were focused solely on investigating and disrupting life.

[198] Noë (2021). *Entanglement and Ecstasy in Dance*. p.72.
[199] Carroll (2017). *Comments on Strange Tools*. p.217.
[200] Noë (2015). *Strange Tools*. p.19.

In Carroll's initial example, a war Dance, this would mean that its function is at odds with the function of art, as described by Noë. What then is the function of a war Dance? To answer this, Carroll briefly discusses the *haka* of the *māori* people, asserting that '[i]ts function is to frighten the enemy. […] Were this choreographic design meant to invite intruders to stay awhile in order to scrutinize its display of ordinary movement, the choreography would defeat its goal of driving off unwelcome invaders.'[201]

This is not entirely correct. Firstly, the *haka* is not exclusively a war Dance. While it is often performed in such a context, the *haka* is also performed as a welcoming ceremony, at funerals, at weddings, at birthdays, at the birth of a child, and for many other occasions.[202] Secondly, and more importantly, Noë does not think that the function of art is to investigate and display ordinary movement, as Carroll suggests, but rather to investigate and display organised activities that can include ordinary movement. In *Strange Tools*, Noë explicitly states as much, writing that '[t]he basic argument of this book is this: Our lives are structured by organization. Art is a practice for bringing our organization into view; in doing this, art reorganizes us.'[203]

These issues aside, with a slight amendment, this criticism of Noë can be made stronger: Art has many different functions, some of which could not be achieved if artists were solely preoccupied with investigating, displaying, and disrupting organised activities. This criticism is again made stronger by Guyer, who previously argued that '[art] will be engaging because it is disruptive, sometimes because it is insightful, but sometimes it may be engaging without being either disruptive or insightful.'[204] In other words, art can function as a

[201] Carroll (2017). *Comments on Strange Tools*. pp.217 – 218.
[202] McArthur Mingon and John Sutton (2021). Why Robots can't Haka: Skilled Performance and Embodied Knowledge in the Māori Haka, *Synthese (Dordrecht).* 199(1–2), pp.4337 – 4365.
[203] Noë (2015). *Strange Tools*. p.29.
[204] Guyer (2017). *Alva Noë, Strange Tools*. p.230.

strange or ordinary tool, with the latter often affirming the organised activities from which it is informed.

This is correct. The previous example of *ikebana*, like many other traditional Japanese arts, is a profound yet ordinary tool that displays the congruent relation between the macrocosmic and the microcosmic. This is a very strong argument against Noë's position, and one which he has yet to address. Traditional Japanese arts, such as *bushidō*, *aikidō*, *jūdō, shodō*, *sadō*, and *ikebana* are ordinary and everyday tools that reveal the world, rather than disrupt it. While these examples can function in the way Noë describes, they also function in a way that reveals and affirms the world. Yet, while Noë may be open to the idea that art can have many different functions, it is arts ability to disrupt and reorganise life which makes art art for him, thereby ruling out many traditional Japanese arts, as well as the traditional arts of many other Asian countries.

6.2 Nishida's Rejoinder to Noë's Critics

It appears we are at an impasse. For Noë, art is necessarily a strange tool. For his critics, as well as in many traditional Japanese arts, art is a tool that can be both strange and ordinary. Considering their similarities, let us see how Nishida might offer a response to Noë's critics. The first criticism that art has many different functions is one that Nishida, like Noë, would expectedly agree. This is because, for Nishida, we both create and are created in the sociohistorical, material, and biological world, thereby encompassing a wide array of functions that unfold and persist through the created work. This is not to say that art does not function in the way Noë describes for Nishida, only that its ability to investigative and disrupt life overlaps with its many other functions. Accordingly, Nishida's broader understanding of organised activities, and the role of art therein, can bridge the gap between the seemingly opposing views of Noë and his critics.

In the example of a war Dance, if we assume that its only function is, as Carroll asserts, to intimidate and frighten the enemy, then this function would be severely compromised if artists were solely preoccupied with investigating and displaying organised activities. An artist comically investigating what life is and can be on the battlefield would, rather swiftly, discover death.

However, we can assume that, for Nishida, a war Dance would be interpreted as having many different functions, performed prior to and proceeding its creation. This is because a war Dance, like all art, is created in and with the sociohistorical, material, and biological world. While artists can investigate what dancing is leading up to the performance, being informed by what has come before, the unfolding war Dance is a performance in and with the material world. It is an expression of the material world that both transcends and includes the individual Dancer. In a war Dance, the physical limitations and affordances of Dancer and world, combined, can inspire fear in a perceiving enemy. A war Dance is also performed in and with the biological world, with the motivations and actions involved being informed by biological imperatives such as, for instance, survival, sexual selection, reproduction, resources, to name but a few. A war Dance is also performed in and with the sociohistorical world, as what is and can be performed is shaped by what has come before, as well as the surrounding cultural and interpersonal context. None of these functions compromise the artist's ability to investigate and display organised activities, as described by Noë. In fact, they are often thereby enhanced.

Accordingly, by investigating the organised activity of dancing, as well as other organised activities such as fighting, war, and so forth, the artist can create new styles of war Dance that can intimidate and strike fear into an enemy. Therefore, Nishida's expanded understanding of Noë's organised activities, and the role of art within, recognises the many

functions of art, while also allowing for the inclusion of a Noë's understanding of art as a strange tool.

This leads us to the second criticism directed at Noë, namely that art is not necessarily a strange tool, often having the ability to affirm and display the world of organised activities from which it is informed. Simply stated, this criticism is that art can be a strange and ordinary tool. Nishida's understanding of art, specifically the role of the artist, can offer a response to Noë's critics here. This is because, as a paradigm example of *kōiteki chokkan,* art is something that 'both transcends and includes personal action'[205] for Nishida. This means that the artist both acts in and is acted upon by the world. Without artistic intuition there would be no artistic action. Without artistic action there would be no artistic intuition. Without a world, there would be no artistic action or intuition. As shown, examples of how art does not necessarily disrupt life can be found in many traditional Japanese arts, as these are forms of art that do not, as Noë argues, seek to disrupt and reorganise life. Instead, these forms of art aim to manifest and cultivate the unity life and world. This why Nishida writes that '[c]ulture too is something which appears through action. Culture is the object of active intuition.'[206] In other words, action and intuition, as Maraldo previously explained, '*shapes the world that in turn shapes us.*'[207] *Kōiteki chokkan* shows how art is not merely the creation of a preexisting artist, but rather the creation of the objective world that both includes and transcends all actions and intuition. In art, Maraldo further explains, both '[a]rtist and work form mutually and are reflected in one another'[208] for Nishida. Therefore, for Nishida, both artist and world are mutually shaped by a creative process that unfolds and persists through the created work.

[205] Nishida (1970). *Fundamental Problems of Philosophy*. p.20.
[206] Ibid. p.227.
[207] Maraldo (2017). *Japanese Philosophy in the Making*. p.199.
[208] Ibid. p.209.

So, while Nishida would expectedly agree with the criticism that art can have many different functions, *kōiteki chokkan* shows how art can simultaneously function as an ordinary and a strange tool. This is because *kōiteki chokkan* places art in its wider context, showing that the true work of art does not begin or end with the artist. Art both includes and transcends the artist, thereby unfolding and persisting as a part of the sociohistorical, biological, and material world.

Accordingly, Nishida's expanded understanding of art recognises that Guyer is correct when he argues that art can function as an ordinary tool, while also recognising that Noë is correct when he says that art functions as a strange tool. Art unfolds and persists in and with a world that both includes and transcends all individuals, including that of the artist. This then gives art the ability to both disrupt or affirm organised activities, as well as the world more generally. Therefore, Nishida offers a response to Guyer's criticism of Noë, showing how art can be a strange and ordinary tool.

Before proceeding, it is important to note that Noë and Nishida discuss tools in quite distinct ways. When Noë describes art as a strange tool, he does so not in the sense of literal tool-making or tool-using, but as an activity that investigates and disrupts organised activities. Art is a "tool" that society and culture uses to liberate itself from the structures of organisation that shape and organise our lives. Unlike literal tools, strange tools evoke reflection, disruption, and reorganisation. A literal tool, in contrast, is a physical object or process that is used for a specific task, such as a hammer, flute, computer, or, as we will see in Chapter 4, entrainment. These tools are used with a clear and defined purpose. While, of course, artworks can also be physical objects, their role as strange tools, for Noë, lies in their capacity to shape and reorganise life.

Nishida discusses literal tool-using and tool-making at length in *Place and Dialectic*, explaining that '[w]e make tools with our hands, and make things with tools. A tool is something separate from our body, it is a *thing*. However, it is through the recognition of tools that one comes to know one's body.'[209] Nishida is saying here that tools, including the human body, are not merely objects or things, but rather allow us to shape the world that, in turn, shapes us. This is why Nishida argues that '[o]ur self exists as an acting self, and we possess tools and make things with tools. Tools are already things and are not extensions of the body.'[210] Krummel and Nagatomo further explain:

> Via body and tool, the human being is interconnected with the world of things. Nishida relates acting-intuition with this toolmaking and tool-using aspect of human activity vis-à-vis the historical world and its dialectical self-formation. The inseparability between seeing and making in acting-intuition is related to the dialectic of the world's own creativity.[211]

For Nishida, tools are not merely instruments; they are embedded in a broader context of action and intuition. In this way, tools are central to *kōiteki chokkan*, as they allow us, individually and collectively, to engage a creativity activity that both includes and transcends our own. While there is much to unpack here, to the extent that Nishida is saying that human tool-making and tool-using allows us to shape the world that shapes us, the relevant point here is that, in contrast to Noë, Nishida views tools, including the human body,[212] as a thing or object that humans use to shape the sociohistorical world that shapes us. For Nishida, tools are literal and physical objects or process that exist independently of the body, but also become integrated with human activity through use. These tools allow us to physically shape

[209] Nishida (2012). *Place and Dialectic.* p.107.
[210] Ibid. p.132.
[211] Ibid. p.117.
[212] See – Ibid., where Nishida writes that 'the body is also a kind of tool' (p.107).

the world which, in turn, shapes us. Thus, for Nishida, tools mediate the interplay between the self and the world, facilitating a continuity between the individual and their sociohistorical context.

In contrast, when Noë describes art as a strange tool, the uses the term "tool" to describe an activity that has no clear and defined *telos*. Art, like philosophy, is an activity. While art can also be a physical object, it is something we, as individuals and as a collective, actively do. For Noë, art is a tool to the extent that its strangeness is something that society and culture uses to investigate and disrupt the norms and practices entailed within. This makes art fundamentally distinct from Nishida's discussion of tools, as Noë's strange tools are not physical objects with specific purposes but rather activities that function to reorganise life, society, and culture. While not referring to art, Nishida explains that '[t]ools exist apart from our body. Moreover, they can become tools of other persons just as they can be tools of the self. We have existence in the world as entities which essentially possess such tools.'[213]

In the context of art, this means that, for Nishida, the strangeness of this "tool" is dependent on who is using it. Art's ability to disrupt or affirm organised activities, to be perceived as strange or ordinary, is conditional on whether or not those experiencing it are part of organised activities which is either affirmed or disturbed by what is created. Noë would expectedly disagree with Nishida here. For Noë, art is the creation of a preexisting artist, as well as the preexisting organised activities from which they are informed. As such, for Noë, the true work of art is done prior to its creation, with the enduring artifact being secondary to the creative activity of an artist. This is what divides Noë from Guyer, as does it divide Nishida from both. By understanding art as the creation of human subjectivity, Noë and Guyer think that it can be either a strange or ordinary tool, and it cannot be both. This is because the true work of art and artist is done prior to its creation. While it does continue on

[213] Nishida (1970). *Fundamental Problems of Philosophy*. p.183.

as a created work, this is secondary to the creative process of a subjective and preexisting artist. Nishida would disagree. For him, art is shaped as much by the artist as it is by the world, being a process that unfolds and persists in a world that both transcends and includes the individual artist and what they create.

6.3 Noë's Rejoinder to Nishida's Critics

Like Noë, Nishida also has his critics, many of whom he used to further develop and clarify his position and chosen terminology. A common criticism, initially given by Satomi,[214] and later by friend turned adversary Tanabe,[215] is that Nishida's terminology implies a kind of psychologism that, as Maraldo explained, 'reduces logic to the contingencies of the individual mind or brain.'[216] Such criticisms are, in no small part, due to Nishida's chosen terminology and somewhat hyperbolic writing style.[217]

For example, as far back as *An Inquiry into the Good*, Nishida often makes statements such as '[t]he individual's experience is simply a small, distinctive sphere of limited experience within true experience.'[218] As is the case in many of his later works, when Nishida often makes statements such as 'consciousness does not belong to the individual; it is a kind of public field. Individual consciousness may be conceived as a special case of such public consciousness,'[219] and that '[c]onsciousness and physical matter are the two aspects of the

[214] Ching-Yuen Cheung (2018). Nishida Kitarō, Takahashi Satomi and the Schelerian Philosophy of Love, In – Andrea Altobrando, Takuya Niikawa, and Richard Stone, eds. (2018). *The Realizations of the Self.* Springer; Palgrave Macmillan. Chapter 14.
[215] See – Tanabe (1986). *Philosophy as Metanoetics*, Chapters 2 and 3. While Tanabe deliberately refuses to refer to Nishida directly in his book. Implicit in much of his work is a criticism of his former friend and colleague.
[216] Maraldo (2019). *Nishida Kitarō*. Second paragraph.
[217] For an in-depth exploration of the academic and personal rivalry between Nishida and Tanabe, see - Sugimoto Kōichi (2011). Tanabe Hajime's Logic of Species and the Philosophy of Nishida Kitaro: A Critical Dialogue Within the Kyoto School, In – Bret W. Davis, Brian Schroeder, and Jason M. Wirth, ed. (2011). *Japanese and Continental Philosophy: Conversations with the Kyoto School*. Indiana; Indiana University Press. Chp.3.
[218] Nishida (1990). *An Inquiry into the Good*. p.19.
[219] Nishida (1970). *Fundamental Problems of Philosophy*. p.186.

underlying medium.'[220] In these examples, among many others, it is easy to see why some critics thought that Nishida's philosophy implies a kind of psychologism that limits his philosophy to the psychology of the individual.

Even *kōiteki chokkan* could be understood in such a manner, as Nishida's chosen terminology can imply that it is the world itself which acts and intuits. While there is a grain of truth in such criticisms, to the extent that, as we will see in Chapter 4, the active world both includes and transcends the *acts* of action and intuition for Nishida, it should be evident by now that this is not accurate.

In his postscript to *An Inquiry into the Good*, written 10 years after its original publication, Nishida reflects on these criticisms, writing:

> As I look at it now, the standpoint of this book is that of consciousness, which might be thought of as a kind of psychologism. Yet even if people criticize it as being too psychological, there is little I can do now. I do think, however, that what lay deep in my thought when I wrote it was not something that is merely psychological.[221]

What Nishida is saying here is that his critics are partially correct, insofar as his philosophy is partially psychologistic.

However, as should now be evident, Nishida's understanding of the world, and our place within, is more ontological than phenomenal. This is because, as James W. Heisig notes, 'Nishida's concern as a philosopher was knowing reality at its most basic level.'[222] It is this that Nishida spent his life trying to articulate, responding to his critics by developing concepts such as "*jikaku*" 自覚 (self-consciousness) and later "*basho*" in response, as we will

[220] Nishida (1970). *Fundamental Problems of Philosophy*. p.209.
[221] Nishida (1990). *Inquiry into the Good*. pp.xxxi - xxxii
[222] James W. Heisig (2001). *Philosophers of Nothingness: An Essay on the Kyoto School*. Honolulu; University of Hawai'i Press. p.51.

see in Chapter 4, Section 1.2.3. While each of these concepts demand considerable investigation, the relevant point for the moment is that in response to claims of psychologism, Nishida iterated on his previous theories and concepts in order to articulate how we act in and are acted upon by an objective world that both transcends and includes the individual. This is the world of *kōiteki chokkan*, the world of action and intuition.

While a prolific writer right up to his death in 1945, Nishida never conclusively overcame the patina of psychologism that many critics found on his philosophy. This is because, as we saw previously in Section 1, even the words "action" and "intuition" carry semantic baggage. The word "intuition" can imply an individual mind, as can the word "action" imply an individual actor. Combined, both can imply cognitive states and processes, phenomenal experiences, as well as a duality between that which acts and that which is acted upon and, ultimately, between subject and object. Accordingly, when Nishida refers to the world of *kōiteki chokkan*, it is easy to see how one might view this as a kind of psychologism.

Noë can help Nishida here, as his similar understanding of life as organised activities offers terminology that both supports Nishida's claim while also avoiding the implications of psychologism. As we saw, Noë and Nishida largely agree that we shape and get shaped by the world around us. This is the world of action and organisation. Drawing on their similarities, we can avoid the criticism of psychologism directed at Nishida by saying that Noë's terminology shows that the world of *kōiteki chokkan* is also the world of organised activities, wherein actions organise the organised activities that, in turn, organise actions.

Nishida may be amenable to the world of action and organisation, given that, as Maraldo notes, '[i]f the world of *koi-teki chokkan* is the very world of pure experience, as [Nishida] eventually recognizes, then it is a more socially embodied and historically placed

"pure experience."'[223] This then retains the original insight of *kōiteki chokkan*, while showing that our actions and intuitions both shape and are shaped, organise and get organised, by the objective world. It also avoids terminology which can be understood as limiting Nishida's philosophy to human psychology. Therefore, while Noë can offer only a sematic response to Nishida's critics, he shows how the world of *kōiteki chokkan* can also be understood as the world of organised activities, wherein actions and intuitions are organised by a world that both transcends and includes the actions and intuitions of the individual.

6.4 Summary and Context

In summary, Nishida and Noë have been shown to share comparable understanding of art, thereby allowing them to respond to each other's critics. As shown, the first criticism that Noë fails to recognise that art has many different functions is a moot point, as Noë and Nishida would likely agree. The second, being that art can also be an ordinary tool that can potentially affirm life, is a much stronger criticism. This is because, for Noë, art is necessarily a strange tool, with any other functions it may have being separate to the core function of disrupting and reorganising life. Nishida offers a response to this criticism, showing how art is shaped as much by the artist as it is by the world, and how this process unfolds and persist in a world that transcends and includes both art and artist. In this way, for Nishida, art can also be an everyday or ordinary tool. Accordingly, Nishida offers a middle path between Noë and his critics, by showing how art can have many different functions, both an ordinary and strange.

Noë can also offer a response to Nishida's critics, if only a sematic one. Noë shows how the world of *kōiteki chokkan* can be understood as the world of action and organisation, wherein our actions and intuitions both organise and get organised by organised activities. Therefore, Nishida and Noë can offer a response to each other's critics, creating a more

[223] Maraldo (2017). *Japanese Philosophy in the Making*. p.200.

robust theory of art that retains their shared insight that we both organise and are organised by our actions and intuitions in and with the world.

Section 7: Conclusion

This chapter has shown how Nishida and Noë share a comparable understanding of art, and how, for both, we can identify art by what it does rather than by what it is, through 'the work *the art itself* achieves.'[224] For Nishida, art is a paradigm example of *kōiteki chokkan*, working to unify action, intuition, and world. For Noë, art works to alter the organised activities from which it is informed. Together, Nishida and Noë demonstrate how artistic actions and intuitions shape a world which, in turn, shapes artistic actions and intuitions. This is Nishida and Noë's world of action and organisation, wherein actions and intuitions both organise and get organised by the world.

This chapter has also highlighted where Nishida and Noë disagree. Firstly, for Nishida, art is not merely the creation of a preexisting artist that then (and only then) works to reorganise life, as argued by Noë. This is because, for Nishida, artistic actions and intuitions arise mutually and from each other, in the sense that what is and can be created by an individual artist is enacted by their activities in and with the world. Accordingly, for Nishida, the true work of art is not accomplished prior to its creation, as Noë contends, but persists and unfolds in and with world that includes and transcends both art and artist. On this, Nishida has an apparently enactivist understanding as, for him, art is, as Varela et al. write, 'the enactment of a world and a mind.'[225]

Secondly, for Noë, art is necessarily a strange tool. While Noë largely agrees with his critics that art can have many other functions, he argues the true work of art is disruptive, in the sense that it aims to liberate us from the organised activities that dominate and shape our

[224] Noë (2015). *Strange Tools*. p.167
[225] Varela et al. (1991). *The Embodied Mind*. p.9.

lives. Exemplified in traditional Japanese arts, Nishida shows that art can then have different functions, both strange and ordinary. By placing both authors in dialogue, with each other as well as their critics, this chapter develops a more robust theory of art, setting the stage for a more grounded investigation into the potential mechanisms underlying Nishida and Noë's world of action and organisation.

However, in the world of action and organisation, how exactly do actions and intuitions organise a world which, in turn, organises actions and intuitions? If the world of action and organisation is material, biological, and sociohistorical, then what are the shared processes and mechanisms that can give rise to these structures of organisation? While these are not a criticism, *per se*, it is difficult to find any practical or meaningful conclusion about the reciprocity between action and intuition, as well as between mind and world, without a clearer understanding of the underlying processes and mechanisms that mediate this relationship.

In the next chapter, the phenomenon of entrainment is presented as an empirical example of Nishida and Noë's world of action and organisation in the material, biological, and sociohistorical world. It is argued that within entrained systems, '[w]holes are more than the sum of their parts'[226] and '[p]arts behave differently in wholes,'[227] exemplifying Gillett's novel theory of emergence, as well as how the behaviour of parts can organise a whole which, in turn, organises the behaviour of parts. Chapter 3 expands on this, looking at neuroecological entrainment between our brains, sensorineural systems, sensorimotor systems, and environmental stimuli, including other people. This chapter also highlights the limitations of current scientific studies examining entrainment, specifically those that mistake intentional synchronisation for spontaneous entrainment. In Chapter 4, Noë's *aesthetic*

[226] Gillett (2016). *Reduction and Emergence*. p.201.
[227] Ibid. p.201.

paradigm is given as a middle way between Nishida's tentative philosophy of science and positivist paradigms and assumptions in contemporary science, arguing that entrainment is a literal tool that artists intentionally use, even if only tacitly, to shape the organised activities that ultimately shape and define what we are: an aesthetic phenomenon.

Chapter 2: Entrainment in the Material, Biological, and Sociohistorical World

Entrainment is a fundamental and pervasive phenomenon that organises much of our reality. Identified in physics, biology, neuroscience, and social interactions, Michael H. Thaut, Gerald C. McIntosh, and Volker Hoemberg define entrainment as 'a temporal locking process in which one system's motion or signal frequency entrains the frequency of another system.'[228] Entrainment is a period of emergent synchronisation that is spontaneously initiated and sustained by the energy transferred between open energy systems. Entrainment is organisation and order in a disorganised and disordered universe.

As such, entrainment extends into the realm of Nishida and Noë's world of action and organisation, providing an empirical example of how our actions shape and organise a world which, in turn, shapes and organises our actions. To explore this, the following chapter is structured into three sections, each individually looking at the presence and implications of entrainment in Nishida's material, biological and sociohistorical world.

Section one identifies entrainment in the material world. The example of two oscillating pendula will be used to show how entrainment is a period of emergent synchronisation that is spontaneously initiated and sustained by energy transfer mechanisms shared between open energy systems.

Section two identifies entrainment in the biological world. By creating an explanatory model, the example of starlings caught up in murmuration will be used to show how the very same phenomenon of entrainment leads to highly complex and organised activities between biological systems.

[228] Thaut et al. (2015). *Neurobiological Foundations*. p.1.

Section three identifies entrainment in the sociohistorical world, showing how material and biological processes and mechanisms, while present, cannot *fully* capture the complexities of this phenomenon. The example of the London Millennium Footbridge, colloquially known as the "Wobbly Bridge," is used to show how, like pendula and starlings, humans can be caught up in processes of entrainment that directly shape what they can and will do.

The central argument of this chapter is that entrainment illustrates the interconnectedness between humans and their environments. It demonstrates how, just like pendula, starlings, and bridges, humans transfer and absorb energy from a world which transfers and absorbs energy from us. Accordingly, entrainment provides a concrete explanation for Nishida and Noë's world of action and organisation, and how action organises the world which, in turn, organises action. This sets the stage for the discussion of neuroecologcial entrainment in Chapter 3, as well as how, as will be shown in Chapter 4, spontaneous entrainment is a tool that artists can intentionally use to shape the organised activities that ultimately shape what we are: an aesthetic phenomenon.

Section 1: Entrainment in the Material World

First identified by Dutch physicist Christian Huygens,[229] the notable inventor of the pendulum clock, entrainment is a phenomenon when energy shared between two or more open energy systems initiates and sustains a period of spontaneous and emergent synchronisation. Huygens first noticed this when he placed two pendula (P1 and P2) side by side on a wall. Over time, he observed that the oscillations of P1 and P2 became increasingly synchronised, continuing until a common frequency emerged and both pendula were swinging in harmony. What Huygens inadvertently discovered is today recognised as entrainment.

[229] Huygens (1707). *Horologium Oscillatorium.*

Thaut et al. explain that within entrained systems, such as P1 and P2, 'the different amounts of energy transferred between the moving bodies […] drives an adjustment process in which the different energy amounts are gradually eliminated to zero until both moving bodies move in resonant frequency or synchrony.'[230] In other words, entrainment between P1 and P2 was an emergent period of synchronisation that was spontaneously initiated and sustained by the exchange of energy between them. In this way, entrainment is a recursive energy system, involving the mutual, reciprocal, and reoccurring transfer of energy. This then creates a self-reinforcing and coupled system that gradually dissipates over time. Among the many examples to follow, including Huygens two pendula, the phenomenon of entrainment has been identified on both the cosmic[231] and the quantum[232] levels, as well as everywhere in between.

1.1 Energy Transfer Mechanisms

To understand how energy shared between two or more open energy systems spontaneously initiates and sustains a period of emergent synchronisation, we must first examine the underlying Energy Transfer Mechanisms (ETM). This is because, in both science and philosophy, the study of mechanisms provides a way to understand processes, just as the study of processes provides a way to understand mechanisms. In 'Thinking about Mechanisms,' Machamer et al. explain that '[m]echanisms are entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions.'[233] Phyllis McKay Illari and Jon Williamson agree, explaining that '[a] mechanism for a phenomenon consists of entities and activities organized in such a way

[230] Thaut et al. (2015). *Neurobiological Foundations*. p. 1.
[231] Kannan et al. (2021;2020). *Dust Entrainment in Galactic Winds*.
[232] Cabot et al. (2021). *Metastable Quantum Entrainment*.
[233] Peter Machamer, Lindley Darden, and Carl F. Craver (2000). Thinking about Mechanisms, *Philosophy of Science*. 67(1), p.3.

that they are responsible for the phenomenon.'[234] In other words, mechanisms are entailed within processes, providing the underlying structures and activities that initiate, sustain, and end changes in systems. Mechanisms are how and why processes take place, from their initial to final state. Specific to the example of entrainment, ETMs govern how energy is transferred and shared between open systems, thereby giving rise to a period of spontaneous and emergent synchronisation. They are how and why the phenomenon of entrainment takes place, evoking the action and organisation within the world of *kōiteki chokkan* and organised activities.

In classical physics, which studies the motion and behaviour of everything from particles to planets, ETMs fall under two general categories: thermodynamics and fluid dynamics. While classical physics encompasses much more than this, thermodynamics and fluid dynamics will be shown to provide sufficient explanations for the process of entrainment in the material, biological, and sociohistorical world. Generally speaking, thermodynamics is the study of the relationships between heat, energy, and mass.[235] Fluid dynamics is the study of liquids, gases, and even plasma, specifically how fluids act and interact, as well as how this can both transfer and transport energy.[236]

This is not to suggest that thermodynamics and fluid dynamics are separate and distinct fields of study. Nor is it to suggest that heat, energy, mass, liquid, gas, or plasma are in any meaningful way different. Energy and mass are equivalent, as Albert Einstein's (1879 – 1955) famous equation ($E = mc^2$) shows,[237] representing different states of entropy as all

[234] Phyllis McKay Illari, and Jon Williamson (2012). What is a Mechanism? Thinking about Mechanisms across the Sciences, *European Journal for Philosophy of Science*. 2(1), p.120.
[235] Peter W. Atkins (2010). *The Laws of Thermodynamics: A Very Short Introduction*. Oxford University Press. Chp.3.
[236] George Keith Batchelor (1999). *An Introduction to Fluid Dynamics (Second paperback ed.).* Cambridge University Press. Chapter 1.
[237] Albert Einstein (1905). Does the Energy of a Body Depend Upon its Energy Content?, In – Anna Beck, trans. (1989). *The Collected Papers of Albert Einstein. Volume 2: The Swiss Years: Writings, 1900-1909.* Princeton; Princeton University Press. pp.172 – 174.

matter and energy in the universe moves from order to disorder.[238] As the overall energy of the universe tends towards disorder, the energy and mass of all systems must eventually dissipate. While this goes far beyond the scope of this work, the relevant point here is that the ETMs of mass and energy are, as we will see, intrinsically linked, often overlapping in significant and inseparable ways. In classical physics, there are four ETMs: conduction, radiation, convection, and advection.[239]

1.1.1 Conduction

The first ETM is conduction. This is the process by which direct contact transfers energy or mass. While conduction is primarily linked to thermodynamics and how systems transfer energy, heat, temperature, and mass to each other, it should be noted that conduction also relates the transfer of energy between fluid and gases. Nonetheless, for the sake of simplicity, consider the example of placing one's hand on a hot stove. In this scenario, it is the ETM of conduction that governs how the thermal energy of the stove is directly transferred to one's hand, as does conduction also transfer energy from the hand to the stove. If, for some odd reason, someone intentionally kept their hand in contact with a hot stove, the conducted energy between both the stove and the hand would eventually equalise, be it relative to each other, or with the ambient temperature of the room, or, as is more likely, with the consistent temperature of the stove.

As this process continues, overall entropy increases. This is because, as Hans Dieter Baehr and Karl Stephan explain, '[t]he second law of thermodynamics states that heat always flows over the boundary of the system in the direction of falling temperature.'[240] Peter W. Atkins expands further, giving that 'the entropy of the of the universe increases in the course

[238] Atkins (2010). *The Laws of Thermodynamics*. p.49.
[239] Hans Dieter Baehr, and Karl Stephan (2006). *Heat and Mass-transfer (Second revised ed.)*. Berlin, Germany; Springer. Chapter 1, specifically sections 1.1 and 1.5.
[240] Baehr, and Stephan (2006). *Heat and Mass-transfer*. p.1.

of any spontaneous change. The key word here is *universe*: it means, as always in thermodynamics, the system together with its surroundings.'[241] In other words, the overall energy of the universe tends towards disorder. The energy of all systems must eventually dissipate. Specific to our example, this means that the conduction of thermal energy between both hand and stove eventually dissipates. Leaving one with a burnt and disordered hand.

However, it is important to distinguish between the above example and the phenomenon of entrainment, as conduction alone does not necessarily lead to synchronisation. While this example does involve conduction between two energy systems, the stove and one's hand, it does not constitute entrainment. This is because the asymmetry between the thermal energy of one's hand and of the stove is insufficient to initiate and sustain a period of synchronisation, in the sense that the energy transferred by the stove is significantly higher relative to that transferred by the hand. While the energy of both stove and hand does eventually equalise, there is no emergent period of synchronisation and organisation initiated and sustained by the energy transfer mechanism of conduction.

However, in thermodynamics, Atkins rightly notes that '[t]here is no prohibition of the system or the surroundings *individually* undergoing a decrease in entropy.'[242] While the overall entropy of the universe always increases, the entropy of individual systems can decrease, provided that there are appropriate mechanisms and processes in place. While the universe tends towards disorder, there can also be brief moments of order. To borrow Erwin Schrödinger's (1887 – 1961) terminology, individual systems can instantiate a kind of negative entropy or "negentropy" in an otherwise entropic universe.[243]

[241] Atkins (2010). *The Laws of Thermodynamics*. p.49.
[242] Ibid. p.49.
[243] Erwin Schrödinger (1944; 1956). *What is life? and Other Scientific Essays*. New York: Doubleday Anchor Books.

We can see this by returning to Huygens' two pendula. As P1 oscillates, it conducts energy to the wall, making it subtly vibrate. As the wall subtly vibrates, it conducts energy to P2, making it oscillate at a slightly different frequency. As P2 oscillates at a slightly different frequency, it too conducts energy to the wall, making it subtly vibrate. As the wall subtly vibrates, it conducts energy to P1, making it oscillate at a slightly different frequency. As this process continues, the frequencies of P1 and P2 become increasingly synchronised until a shared frequency emerges. In this example, the energy conducted between P1 and P2 via the wall is sufficient to spontaneously initiate and sustain a period of emergent synchronisation. the process of entrainment. P1 and P2 are entrained.

Accordingly, there is a reciprocity between P1 and P2, in the sense that the energy conducted between initiates and sustains a self-reinforcing process—a kind of feedback loop—which increasingly synchronises the oscillations of both. Like the example of a hand placed on a hot stove, as this process continues between P1 and P2 overall entropy increases. Meaning that the energy of P1 and P2 eventually dissipates, thereby leading to the cessation of entrainment between both pendula.

There is an important difference between this example and the previous. While the overall entropy in both examples does increase, becoming increasingly disordered, entrainment is brief moment of order in an increasingly disordered universe. Entrainment organises an increasingly disorganised universe, provided that the energy transferred between is sufficient. Thus, conduction is the primary ETM that governs the entrainment between two pendula, conditional on the energy transferred between being sufficient to spontaneously initiate and sustain a period of emergent synchronisation.

1.1.2 Radiation

The second ETM is radiation. This is the process by which energy is transferred by way of electromagnetic waves. In contrast to conduction, which is the transfer of energy through physical contact, radiation is the transfer of energy via mediums, such as air, water, or even through empty space, such as in a vacuum.[244] Baehr and Stephan explain that '[a]ll forms of matter emit energy to their surroundings through electromagnetic waves. […] This type of energy release is known as thermal radiation or heat radiation.'[245] In other words, when matter emits energy, these waves can travel through the surrounding environment, being absorbed by other forms of matter, thereby transferring energy between systems. As with conduction, and in accordance with the second law of thermodynamics, the energy transferred by way of radiation must eventually dissipate.

In the example of a hot stove, thermoreceptors in the hand allow one to feel the radiating heat. This is because any 'internal energy of the emitting body [i.e., the stove] is converted into energy of the electromagnetic waves.'[246] In this way, the hot stove emits energy into its surrounding by agitating the surrounding air molecules, causing them to vibrate. As these molecules vibrate, they then agitate the surrounding air molecules, causing them to vibrate also. As this process continues, the emitted energy of the stove propagates and radiates throughout its environment, getting absorbed by the molecules and thermoreceptors of the hand.

Similarly, one can hear the ticking of a pendulum clock. As the pendulum swings, it agitates and disturbs the surrounding air. Like a pebble thrown into a pond, waves of acoustic energy, being a form of kinetic mechanical energy that is transferred by the medium of air,

[244] Baehr, and Stephan (2006). *Heat and Mass-transfer*. p.503.
[245] Ibid. p.25.
[246] Ibid. p.506.

propagate and radiate throughout the surrounding environment, finally being absorbed by the small bones of the inner ear and heard as a sound.

As with conduction, it is important to distinguish between the above examples and the phenomenon of entrainment. This is because the ETM of radiation alone does not necessarily lead to synchronisation. Whether it is a stove, a ticking pendulum, a hand, or an ear, '[a]ll forms of matter emit energy to their surroundings through electromagnetic waves,' [247] yet not all emitted energy is sufficient to spontaneously initiate and sustain a period of emergent synchronisation. The asymmetry between of energy emitted between a hand and a stove, or a pendulum and an ear, is such that the energy radiated from one is significantly higher relative to that radiated by the other. There is no significant recursion between them, in the sense that the reciprocal energy radiated does not interact in and meaningful way, if at all. Thus, in these two examples, there is no period of emergent synchronisation that is initiated and sustained by the energy transfer mechanism of radiation.

Returning to Huygens' two pendula, while the strongest ETM here is conduction, P1 and P2 also emit rhythmic disturbances of the surrounding air, thereby providing a form of kinetic mechanical energy that can, in principle, reciprocally affect each other. As P1 oscillates, it transfers energy to the surrounding air molecules, thereby disturbing and agitating them. As the air molecules become disturbed and agitated, they do likewise for the surrounding air molecules that, eventually, radiates energy from P1 to P2, making the latter oscillate at a slightly different frequency. Conversely, as P2 oscillates, it too transfers energy to the surrounding air molecules, thereby disturbing and agitating them. As theses air molecules become disturbed and agitated, they eventually radiate energy from P2 to P1, making the latter also oscillate at a slightly different frequency. As this process continues, the

[247] Baehr, and Stephan (2006). *Heat and Mass-transfer*. p.25.

frequencies of P1 and P2 become increasingly synchronised until a shared frequency emerges.

Of course, if P1 and P2 are not of a sufficient enough size, or are separated by too far a distance, this process could not take place. The energy transferred by each would dissipate long before it reached the other in any meaningful way. Nevertheless, if both are of a sufficient size, as well as distance, then there is a recursion between them. The reciprocal energy radiated by and between them could initiate and sustain a self-reinforcing process which increasingly synchronises the oscillations of both. Like the previous example, as this process continues, overall entropy increases. This means that the shared energy of P1 and P2 eventually dissipates, leading to the cessation of entrainment between both.

In this regard, there is a difference between this example and feeling or hearing radiated energy. While the overall entropy in all examples does increase, the entrainment between P1 and P2 is, once again, a brief moment of order in an increasingly disordered universe. Entrainment is initiated and sustained by the ETM of radiation. We will revisit the ETM of radiation in Chapter 3, Section 2, where sensorineural entrainment will show that radiated energy can evoke periods of spontaneous and emergent synchronisation between humans and acoustic or optical stimuli, including interactions with other people. Thus, radiation can govern the entrainment between two or more systems, provided that the energy transferred between is sufficient to initiate and sustain a period of emergent synchronisation.

1.1.3 Convection

The third ETM is convection. This is the process by which energy is transferred by the movement of fluids. While convection is linked to fluid dynamics, insofar as it is the mechanism that governs how liquids, gases, and plasma transfer energy, it is also linked to thermodynamics. This is because, as George Keith Batchelor notes, '[t]he distinction between

solids and fluids is not a sharp one, since there are many materials which in some respects behave like a solid and in other respects like a fluid.'[248] Accordingly, convection also relates the transfer of energy between physical matter. However, unlike conduction and radiation, which require a medium to transfer energy, convection is the medium itself. Convection involves the movement of fluids, and how they transfer energy.

Consider the example of a pot of water placed on a hot stove. The same as with a hand, a pot on a stove absorbs thermal energy by way of conduction. Similarly, if the stove consists of a metal grate placed over an open flame, for example, the pot of water can also absorb radiated energy. In both cases, the thermal energy transferred from the stove is absorbed by the bottom of the pot. This then agitates and heats up the closest water molecules. Due to their molecular structure, water molecules become less dense relative to temperature,[249] meaning that those water molecules closest to the bottom of the pot start to rise. In so doing, the relatively denser and cooler water molecules, closer to the top of the pot, become displaced and start to fall. This process of so-called thermal buoyancy then creates a circulation pattern where hot water rises and cold water falls, with each experiencing changes in temperature and density relative to the other. It is important to note that as hot water rises it also transfers thermal energy to the surrounding cold water, and vice versa, causing a convection current. In this way, energy is transferred by the movement of the fluid itself. As convection continues, the pot of water reaches a uniform temperature. Then, like all energy systems, it is subject to the second law of thermodynamics, whereby the system's overall entropy increases over time and eventually dissipates.

As with the previous two ETMs, it is important to distinguish between this example and the phenomenon of entrainment. Convection alone does not necessarily lead to

[248] Batchelor (1999). *An Introduction to Fluid Dynamics*. p.1.
[249] Ibid. Chapter 1.

synchronisation between energy systems. While the boiling pot of water does illustrate the convection between hot and cold water molecules, as well as the reciprocity between, this process does not initiate and sustain a period of emergent synchronisation. This is because the initial asymmetry of energy transferred between the stove and the pot, as well as the consistent temperature offered by the hot stove, is insufficient to initiate a self-reinforcing or feedback loop between water molecules.

A clearer example of how entrainment can be initiated and sustained by convection can be seen in the Earth's atmosphere, specifically in cases of thermal buoyancy between air molecules. Like water molecules, air molecules are subject to fluid dynamics. As their temperature increases, air molecules become less dense and rise. Conversely, as their temperature decreases, air molecules become denser and fall. In short, hot air rises and cold air falls.

Just as with the convection between hot and cold water molecules, the convection between hot and cold air molecules in the Earth's atmosphere also allows them to transfer energy to each other as they rise and fall. The rising hot air warms up due to the sun's radiation, the conducted and radiated heat from the Earth, as well as a myriad of other contributing factors, both natural and human made. As air rises, it becomes increasingly cooler as it travels through the different layers of the Earth's atmosphere, continuing until it becomes less dense and starts to fall. As cooler air falls, it interacts with and absorbs energy from rising warm air, creating a circulation pattern and convection current that sustains our planet's atmosphere and environment. Consequently, in the atmosphere of the Earth, hot and cold air dynamically interact. They transfer energy to one another as well as to and with their surroundings.

Like all previous examples, as this process continues overall entropy increases. This means that the energy eventually dissipates, thereby leading to the cessation of entrainment between both and, as a consequence, us humans as a species. While the overall entropy in all examples does increase, becoming increasingly disordered, the entrainment between air molecules in the Earth's atmosphere is brief moment of order in an increasingly disordered universe that is initiated and sustained by convection.

Admittedly, this is an oversimplification. The chemistry and physics of the Earth's atmosphere is vast and complex. Atmospheric convection is only one of many influences, both terrestrial and cosmic, that can contribute to global weather patterns.[250] Nonetheless, atmospheric convection is still recognised as a key factor in understanding the interactions between air and sea,[251] as well as how the atmosphere redistributes pollutants.[252] It is essential for sustaining life on earth, as well as maintaining our planet's atmosphere and environment.

Specific to the topic at hand, several simulations created by Anber et al. indicate that 'entrainment plays a critical role in the simulated equilibrium climate sensitivity,'[253] in the sense that minor alterations had a noticeable impact on the overall behavior of the system. Put another way, parts altered the behavior of the whole. It can thus be said that convection can govern the entrainment between two or more systems, provided that the energy transferred

[250] Zhenning Li, Song Yang, Chi-Yung Tam, and Chundi Hu (2021). Strengthening Western Equatorial Pacific and Maritime Continent Atmospheric Convection and its Modulation on the Trade Wind During Spring of 1901–2010, *International Journal of Climatology*. 41(2), pp.1455 – 1464.
[251] Samson Hagos, Gregory R. Foltz, Chidong Zhang, Elizabeth Thompson, Hyodae Seo, Sue Chen, Antonietta Capotondi, Kevin A. Reed, Charlotte DeMott, and Alain Protat (2020). Atmospheric Convection and Air-sea Interactions over the Tropical Oceans: Scientific Progress, Challenges, and Opportunities, *Bulletin of the American Meteorological Society*. 101(3), pp.E253 – E258.
[252] Russo, M. R., Marécal, V., Hoyle, C. R., Arteta, J., Chemel, C., Chipperfield, M. P., Dessens, O., Feng, W., Hosking, J. S., Telford, P. J., Wild, O., Yang, X., and Pyle, J. A. (2011). Representation of Tropical Deep Convection in Atmospheric Models-part 1: Meteorology and Comparison with Satellite Observations, *Atmospheric Chemistry and Physics.* 11(6), pp.2765 – 2786.
[253] Usama M. Anber, Scott E. Giangrande, Leo J. Donner, and Michael P. Jensen (2019). Updraft Constraints on Entrainment: Insights from Amazonian Deep Convection, *Journal of the Atmospheric Sciences*. 76(8), p.2430.

between is sufficient to spontaneously initiate and sustain a period of emergent synchronisation.

1.1.4 Advection

The fourth ETM is advection. In contrast to convection, which is the transfer of energy between moving fluids, advection is the process by which energy is transported *by* moving fluids. As such, advection is intrinsically linked to fluid dynamics and convection, while being a separate and distinct mechanism.

In the previous example of thermal buoyancy, where the convection between air molecules sees them rise and fall relative to each other in the Earth's atmosphere, advection is the mechanism that explains how rising and falling air molecules transport other forms of energy and matter. Advection, for example, governs how hot air balloons ascend and descend, how planes and birds fly, as well as how pollutants and contaminants get spread across the globe. This is further complicated by the fact that air molecules of different densities also transport each other. Guido Visconti and Paolo Ruggieri explain, writing that 'cold air will be *advected* towards warm air that will tend to be cool [and] warm air will be *advected* towards cold air that will tend to be warm.'[254] Simply put, warm air can be transported by cold air, and cold air can be transported by warm air. As with convection, atmospheric advection is essential for life on earth, being a key factor in the maintenance of our planet's atmosphere and environment.

Advection is also evident in the Earth's oceans. While more obvious examples, such as boats, fish, and a worrisome amount of pollution, are all instances of water molecules transporting other forms of energy and matter, water molecules of different densities can also transport each other. Warm water from the equator, being heated by the energy radiated from

[254] Guido Visconti, and Paolo Ruggieri (2020). *Fluid Dynamics: Fundamentals and Applications (1st ed.).* Cham; Springer International Publishing. p.21

the sun, moves towards the Earth's poles, being relatively cooler due to their distance from the sun. Cool water from the poles, conversely, moves towards the Earth's equator. Just like warm and cool air, warm water will be advected towards cool water, and vice versa. In other words, warm water can be transported by cold water, just as cold water can be transported by warm water This dynamic advection process contributes significantly to climate regulation, has an impact on the distribution of marine life, and provides the basis for many ocean currents.

It is, once again, important to distinguish between this example and the phenomenon of entrainment. Advection alone does not necessarily lead to synchronisation between systems. While atmospheric advection does illustrate how hot and cold molecules can transport other forms of energy, as well as each other, this process does not necessarily initiate and sustain a period of emergent synchronisation. This is because the Earth's environment is much more complex than any one mechanism, being open to a myriad of energy systems, be they terrestrial or cosmic.

A relatively simpler example of how entrainment can be initiated and sustained by advection is seen in certain cases of coastal erosion. Specifically, those cases where materials and sediment removed from the coastline further contribute to the process of coastal erosion.[255] Separate from entrainment, coastal erosion happens when tides and currents transport materials and sediment from the coastline and deposit them out to sea via the ETM of advection. In some cases, the materials and sediments transported out to sea are also carried back to the coastline. As these transported materials and sediments reach the coastline, they increase the rate at which coastal erosion takes place by providing an added

[255] Luc Deike, Luc Lenain, and W. Kendall Melville (2017). Air Entrainment by Breaking Waves, *Geophysical Research Letters*. 44(8), pp.3779 – 3787; and Jan De Leeuw, Michael P. Lamb, Gary Parker, Andrew J. Moodie, Daniel Haught, Jeremy G. Venditti, and Jeffrey A. Nittrouer (2020). Entrainment and Suspension of Sand and Gravel, *Earth Surface Dynamics*. 8(2), pp.485 – 504.

abrasive force. The more the ocean erodes the coastline, the more material and sediment it transports. The more materials and sediment it transports, the more it erodes the coastline. As this continues, advection initiates and sustains a self-reinforcing process of entrainment which, often problematically, accelerates the rate at which coastal erosion takes place. Thus, as this example shows, advection can govern the entrainment between two or more systems if the energy transferred between is sufficient to spontaneously initiate and sustain a period of emergent synchronisation.

1.2 The O.R.D.E.R in Disorder

Entrainment has five features, all of which are exemplified in Huygens' two pendula. Firstly, P1 and P2 are an *open* system. With one possible exception, that of the entire universe, there is no such things as a perfectly closed energy system. All energy and mass transfer and absorb energy. This is true regardless of when or where one is born, equally so if one were never born at all. So consistently has this been proven since the early 18th Century, at the very least, that a paradigm shift in science and society would be required to attempt to refute it. It would require a revaluation, and possible dismissal, of most of what we know about the world and cosmos around us. Perhaps such a revaluation will be necessary at some point in the future, as with many other scientific principles. However, philosophers and scientists—the former more than the latter—should be careful not to dismiss foundational scientific principles and theories without positing alternative explanations of equal merit. Thus, P1 and P2, like everything within the known universe, are an open energy system, both transferring and absorbing energy from each other as well as their surroundings.

Secondly, P1 and P2 are also a *resonating* system. Individually, Douglas C. Giancoli explains, 'a simple pendulum moving back and forth […] oscillates along the arc of a circle with equal amplitude on either side of its equilibrium point (where it hangs vertically) and as

it passes through the equilibrium point it has its maximum speed.'[256] This is the *natural frequency* of a simple pendulum. Importantly, this natural frequency is a tendency, as it is the inherent range of motion that a system tends to oscillate at, even when inert or unmoving.[257] P1 and P2, when relatively still, have a natural tendency to oscillate within a certain range of movement or frequency.

A *forced frequency*, in contrast, is when an external force initiates a systems natural frequency by one or more ETM. This can be as simple as Huygens initially setting both pendula in motion, thereby conducting energy from his hand to each pendulum, or as complex as P1 and P2 conducting energy to the wall and each other. The point is, if the energy transferred is sufficient, then a forced frequency is initiated.

Resonance occurs when a forced frequency is of similar amplitude to a natural frequency. Giancoli uses the example of pushing and child on a swing to explain:

> A swing, like any pendulum, has a natural frequency of oscillation. If you were to close your eyes and push on the swing at some random frequency, the swing would bounce around and reach no great amplitude. But if you push with a frequency equal to the natural frequency of the swing, the amplitude increases greatly. This illustrates the fact that at resonance, relatively little effort is required to obtain a large amplitude.[258]

Similarly, when P1 oscillates within its natural frequency, any force similar or equal to this, in this case P2 oscillating within its own natural frequency, can increase P1s amplitude.

This is a kind of downward resonance, where the frequency of P1 is "pulled up" by the frequency of P2. However, there can be upward resonance too, as the frequency of P2

[256] Douglas C. Giancoli (1988). *Physics for Scientists and Engineers (Second ed.).* United States, New Jersey; Prentice-Hall. pp.334 – 335.
[257] Giancoli (1988). *Physics for Scientists and Engineers.* pp.341 – 345.
[258] Ibid. p.343.

also “pulls down” the frequency of P1. This is because P1 and P2 have a similar natural frequency, thereby having a natural tendency to oscillate within a similar range of movement. When individually oscillating, the ETM and resonance between allows the higher frequency to “pull up” the amplitude of the lower, as does it allow the lower frequency to “pull down” the amplitude of the higher. This feature, to be further discussed in Section 2.4 of this chapter, will be important going forward, as it demonstrates a kind of upward and downward resonance where ‘[w]holes are more than the sum of their parts’[259] and ‘[p]arts behave differently in wholes.’[260] Thus, P1 and P2 are a resonating system, with their shared ETMs and natural frequencies evoking both upward and downward resonance.

Thirdly, P1 and P2 are a *dissipating* system. It is trivially true that P1 and P2, like everything else in the universe, are subject to entropy. Accordingly, any coupling between them must end. Less trivially, given that P1 and P2 are open systems, they are also subject to many other ETMs and external forces. This can contribute to the dissipation of energy in and between both pendula, rapidly ending the coupling between. Giancoli offers a clear explanation:

> The amplitude of any real oscillating […] pendulum slowly decreases in time until the oscillations stop altogether. […] This is called dampened harmonic motion. The damping is generally due to the resistance of air and to internal friction within the oscillating system. The energy that is thus dissipated to thermal energy is reflected in a decreased amplitude of oscillation.[261]

While Giancoli is only referring to a single pendulum here, this dampened harmonic motion is also applicable to P1 and P2. There are a myriad of external forces that can subtly or

[259] Gillett (2016). *Reduction and Emergence*. p.201.
[260] Ibid. p.201.
[261] Giancoli (1988). *Physics for Scientists and Engineers.* p.338. Emphasis removed.

overtly dampen the combined oscillations of Huygens' two pendula. Thus, P1 and P2 are also a dissipating system, with any coupling between inevitably ending.

Fourthly, P1 and P2 are an *emergent* system. This system represents a spontaneous period of emergent synchronisation and order in an increasingly disordered universe. Notably, this synchronisation is spontaneously initiated and sustained by the resonating transfer of energy between both pendula. In this context, the word "spontaneous" means that synchronisation emerges naturally from systems' inherent interactions without external intervention. This is when downward resonance "pulls up" the amplitude of the lower frequency, as upward resonance "pulls down" the amplitude of the higher frequency. As the resonance continues synchronisation emerges, with both pendula gradually finding a similar frequency, be it in phase or antiphase. This is also an important feature, as synchronisation is often mistaken for entrainment when, in fact, it is an emergent feature. This distinction will be particularly evident in Chapter 3, Sections 3.2 and 3.3, as interpersonal studies will be shown to identify entrainment where there is only synchronisation. In Chapter 4, Section 3.1, a further distinction will be made between intentional synchronisation and spontaneous entrainment, with Section 3.2 then showing how spontaneous entrainment is a tool that artists can intentionally use to shape the world of action and organisation that shapes what we are: an aesthetic phenomenon. Thus, P1 and P2 are an emergent system, with the synchronisation between being spontaneously initiated and sustained by the transfer of energy.

Finally, P1 and P2 are a *rhythmic* system. P1 oscillates within its natural frequency, as does P2. When coupled and resonating, P1 and P2 oscillate at an increasingly synchronised frequency. Therefore, P1 and P2 display a rhythmicity. While rhythm, as a concept, encompasses many different disciplines, the rhythm referred to here is an ontological descriptor.

Physicist James Clerk Maxwell (1831 – 1879), in a letter to philosopher and psychologist Herbert Spencer (1820 - 1903), succinctly explains: 'as I understand the word rhythmic, it implies not only alteration, but regularity and periodicity.'[262] Over a century later, in 'The Ontology of Rhythm,' Peter Simons further explains using the example of a pendulum:

> Each swing, first one way, then the other, resembles earlier and later swings, so there are repetitions. The double swing, to and fro, is a temporal part or subprocess of the longer process of swinging, and these subprocesses come one after the other in a repetitive way, until the process stops or runs down. So it is of the essence of processes with rhythm that there be successive subprocesses of generally like kind.[263]

Maxwell and Simons are both saying here that rhythm, in the ontological sense, is the recurring, periodic, and oscillating pattern of certain processes. An ontological rhythm is, a Simons puts it, 'a property, not a substance.'[264] Thus, P1 and P2 are a rhythmic system that, individually and coupled, display a recurring, periodic, and oscillating pattern.

1.3 Summary and Context

In summary, entrainment can thus be understood as an *open, resonating, dissipating, emergent,* and *rhythmic* (ORDER) system. Wherever the ETMs of conduction, radiation, convection, or advection allow for the coupling of two or more systems, there is the potential for entrainment. However, not every coupled system is an example of entrainment. This is because entrainment emerges *iff* there is an ORDER system, and when the ETMs are sufficient to spontaneously initiate and sustain a period of emergent synchronisation.

[262] James Clerk Maxwell (1873), cited in Ewan Jones (2018). Thermodynamic Rhythm: The Poetics of Waste, *Representations*. 144(1), p.62.
[263] Peter Simons (2019). The Ontology of Rhythm, In – Peter Cheyne, Andy Hamilton, and Max Paddison, eds. (2019). *The Philosophy of Rhythm: Aesthetics, Music, Poetics* (1st ed.). Oxford University Press. Chapter 3, p.63.
[264] Simons (2019). *The Ontology of Rhythm*. p.63.

Therefore, entrainment is an ORDER system in an increasingly entropic universe—the ORDER in disorder.

In context, the phenomenon of entrainment in the material world exemplifies Nishida and Noë's world of action and organisation. In Chapter 1, Section 4.4, this was described as a world where what we can and will do shapes the world which, in turn, shapes what we can and will do. An ORDER system, as previously described, illustrates a process where the behaviour of parts organises the system as a whole which, in turn, organises the behaviour of its parts. This means that both entrainment and Nishida and Noë's world of action and organisation involve a dynamic process where wholes and parts both shape and are shaped by each other.

In Chapter 1, Section 1, Nishida was shown to separate the world into material, biological, and sociohistorical realms, all of which are different standpoints for viewing reality. Having identified entrainment in the material world, exemplified by two pendula, the following two sections will now identify entrainment in the biological and sociohistorical world, showing how the world of action and organisation encompasses Nishida's tripartite reality. This will be expanded upon in Chapter 3, with neuroecological entrainment showing how the world of action and organisation also includes human neurobiology and perceived environments, including other humans. This will become increasingly important in Chapter 4, as entrainment will be shown to be an ORDER system that artists can intentionally use to shape the organised activities that ultimately shape what we are: an aesthetic phenomenon.

Section 2: Entrainment in the Biological World

Just like pendula, all biological life on Earth is an open energy system. Whether it is an animal, bacteria, fungi, plant, or single-celled, all living organisms on Earth have the ability to both transfer and absorb energy. As such, the biological world is subject to the very

same mechanisms as the material world, in that both are just different standpoints for viewing reality. This means that thermodynamics and fluid dynamics, along with the ETMs of conduction, radiation, convection, and advection, are all applicable to life, as is the phenomenon of entrainment and the ORDER system it entails.

In *What is life?*, Erwin Schrödinger notes that 'from the structure of living matter, we must be prepared to find it working in a manner that cannot be reduced to the ordinary laws of physics.'[265] Of course, this is not to suggest that life is in any way separate from the laws of physics or the material world, but that, as Schrödinger later explains, '[t]he unfolding events in the life cycle of an organism exhibits admirable regularity and orderliness, unrivalled by anything we meet with in inanimate matter.'[266] In other words, the mechanisms and order (and ORDER) found in the biological world are uniquely complex in comparison to those of the material world.

This is because biological organisms have many properties not directly found in the material world, such as adaptability, autonomy, death, evolution, reproduction, and so on.[267] Humans, at the very least, are also thinking and experiencing animals. We are conscious of our surroundings, having intentions and intentionality. We deliberate and reflect on our lives, as well as the many different experiences and mechanisms it entails. Crucially, as we will see in Chapter 4, Section 3.1, intention, whether it be shared or individual, planned, or enacted, is something other than spontaneous entrainment.

[265] Schrödinger (1944). *What is life?* p.74.
[266] Ibid. p.74.
[267] Bernd Rosslenbroich (2016). Properties of Life: Toward a Coherent Understanding of the Organism, *Acta Biotheoretica*. 64(3), pp.277 – 307.

Nevertheless, entrainment in the animal kingdom is a well-studied phenomenon, even if, as will be shown, it is erroneously called synchronisation at times. Chorusing frogs,[268] swarms of insects,[269] schools of fish,[270] crowds clapping in unison,[271] and flocking birds,[272] such as starlings (*Sturnus vulgaris*), all are recognised examples of what O'Keeffe et al. call 'swarmalators [where] both synchronization and swarming occur together.'[273]

2.1 Entrainment Between Two Starlings

Before we consider entrainment in the context of humans in Section 3 of this chapter, as well as in Chapter 4, let us first consider a relatively simpler example: starlings in flight. As a solitary starling (S1) rhythmically beats its wings, these oscillations transfer kinetic energy to the surrounding air molecules by way of conduction, while radiating thermal energy or body heat. S1 also absorbs the radiated heat of the sun, and, more generally, from the ambient temperature of its surroundings.

However, while the energy conducted and radiated from S1 does get absorbed by the surrounding air molecules, causing them to vibrate and decrease in density, this is unlikely to have a significant effect on either S1 or the surrounding air. Likewise, while the energy absorbed by S1 can have subtle effects, potentially altering the starlings' wings and feathers in a way that could influence its flight dynamics, this is also unlikely to have a significant or even noticeable effect. This is because the energy conducted and radiated between S1 and its

[268] Ikkyu Aihara, Hiroyuki Kitahata, Kenichi Yoshikawa, and Kazuyuki Aihara (2008). Mathematical Modeling of Frogs' Calling Behavior and its Possible Application to Artificial Life and Robotics, *Artificial Life and Robotics*. 12(1-2), pp.29 – 32.
[269] Jérôme Buhl, David J. T. Sumpter, Iain D. Couzin, Jeffrey J. Hale, Emma Despland, Elizabeth R. Miller, and Stephen J. Simpson (2006). From Disorder to Order in Marching Locusts, *Science (American Association for the Advancement of Science).* 312(5778), pp.1402 – 1406.
[270] David J. T. Sumpter (2010). *Collective Animal Behavior (1st ed.).* Princeton University Press. Chapter 5.
[271] Z. Néda, E. Ravasz, T. Vicsek, Y. Brechet, and A. L. Barabási (2000). Physics of the Rhythmic Applause, *Physical Review E, Statistical Physics, Plasmas, Fluids, and Related Interdisciplinary Topics*. 61(6:B), pp.6987 – 6992.
[272] William Bialek, Andrea Cavagna, Irene Giardina, Thierry Mora, Edmondo Silvestri, Massimiliano Viale, and Aleksandra M. Walczak (2012; 2011). Statistical Mechanics for Natural Flocks of Birds, *Proceedings of the National Academy of Sciences – PNAS*. 109(13), p.4786.
[273] Kevin P. O'Keeffe, Hyunsuk Hong, and Steven H. Strogatz. (2017). Oscillators that Sync and Swarm, *Nature Communications*. 8(1), p.1504.

surroundings is relatively small in comparison to the other forms of energy being transferred by the sun, the temperature of Earth, and so forth. Thus, conduction and radiation, while present, do not transfer enough energy between S1 and its environment to have any significant effect on either.

What does have a significant effect on both S1 and its surroundings are the ETMs of convection and advection. It is advection that S1 exploits when flying, being transported by the surrounding air currents and fluid dynamics. Advection generates new patterns of air as S1 rhythmically beats its wings. As S1 lifts its wing, this pushes air molecules upwards. This then creates a vacuum, or low pressure zone, beneath its wing, allowing the surrounding air molecules to flow into the area of displacement below. As S1 drops its wing, this pushes air molecules downwards, creating a vacuum above its wing, and allowing the surrounding air molecules to flow into the area of displacement above. As S1 continues to rhythmically beat its wings up and down within its natural frequency, this generates convection currents and patterns of air such as vortices, lift, thrust, and drag, as well as what is commonly referred to as upwash and downwash.[274] These have a significant effect on the advection between both S1 and the surrounding air, as the generated patterns of air propagate away from S1 into the surrounding environment by way of convection before dissipating, much like the waves created by a pebble dropped in a pond.

Let us now add a second starling (S2), taking all of the above and multiplying it by two. For the most part, the energy conducted and radiated between S2 and its surroundings is also relatively small in comparison to the other forms of energy being transferred, meaning that conduction and radiation are also unlikely to have any significant effect on either. However, if S2 were to come into physical contact with S1, say, in a direct collision, then the

[274] T. Alexander Dececchi, Hans C. E. Larsson, and Michael B. Habib (2016). The Wings Before the Bird; an Evaluation of Flapping-based Locomotory Hypotheses in Bird Antecedents, *PeerJ*. 2159(7), pp.1 – 41.

energy conducted between them would indeed be significant. It would directly effect S1 and S2, how they fly, and the generated patterns of air. This is because, unlike P1 and P2, which are firmly attached to a wall, S1 and S2 can decouple from one another with relative ease. In the case of a direct collision between S1 and S2, for example, the energy conducted between them forcibly decouples the two.

A more consistent coupling between S1 and S2 can be achieved by way of convection and advection. As S1 and S2 rhythmically beat their wings up and down, both have a similar natural frequency which generates convection currents and patterns of air that have a significant effect on the advection between both starlings and the surrounding air. As these generated patterns of air propagate away from both S1 and S2, they interact with each other creating interference patterns in the surrounding air molecules, much like that of two pebbles dropped in a pond creating ripples that interact and interfere with each other.

Provided that the distance between S1 and S2 is sufficiently small enough, these generated patterns of air can directly affect what each can and will do. When S1 rhythmically beats its wings, it generates vortices of air that can directly affect the advection between S2 and the surrounding air, and vice versa.

This is because vortices of air create upwash and downwash, among other things, that birds often exploit when flying. When looking at the so called V formations of Northern Bald Ibises (*Geronticus eremita*), Portugal et al. explain:

> such aggregations give an energetic benefit for those birds that are flying behind and to one side of another bird through using the regions of upwash generated by the wings [just as] when birds fly immediately behind another bird—in a streamwise

> position—[…] could potentially reduce the adverse effects of downwash for the following bird.[275]

In other words, the propagating convection currents generated by one bird can be exploited by another by way of advection. Many birds, both literally and figuratively, ride the waves generated by each other. While a V formation of birds is quite different from our example of two starlings, more so when we look at a murmuration in Section 2.3 to follow, it remains that S1 and S2 have the ability to generate patterns of air that directly affect what the other can and will do.

Of course, S1 and S2 can still decouple with relative ease. If, for instance, a predator was to attack, S1 and S2 can swiftly distance themselves from each other and, more importantly, the predator. Even the slightest of breezes can decouple S1 and S2. This is because S1 and S2, like all other animals, are not cogs caught up in the mechanisms of the material world. Unlike P1 and P2, all animals, ourselves included, are open energy system that can, it seems, deliberately or perhaps intentionally decouple from each other with relative ease.

Nevertheless, in the case of S1 and S2, the generated patterns of air can, in principle, spontaneously initiate and sustain a period of entrainment. As S1 rhythmically beats its wings, it transfers kinetic energy to the surrounding air molecules, thereby generating patterns of air and convection currents. As these patterns and current propagate away from S1, they subtly alter how S2 rhythmically beats its wings by way of advection. Conversely, as S2 rhythmically beats its wings, it too transfers kinetic energy to the surrounding air molecules, thereby generating patterns of air and convection currents. These patterns and currents also propagate away from S2, they subtly alter how S1 rhythmically beats its wings

[275] Steven J. Portugal, Tatjana Y. Hubel, Johannes Fritz, Stefanie Heese, Daniela Trobe, Bernhard Voelkl, Stephen Hailes, Alan M. Wilson, and James R. Usherwood (2014). Upwash Exploitation and Downwash Avoidance by Flap Phasing in Ibis Formation Flight, *Nature (London)*. 505(7483), p.399.

by way of advection. As this continues, the similar natural frequencies of S1 and S2's rhythmic wing beats become increasingly synchronised, in the sense that a shared frequency emerges by way of resonance. Like all other energy systems, this coupling must eventually dissipate, leaving S1 and S2 to go their separate ways. Thus, S1 and S2 can form an ORDER system, provided both birds are at a sufficient enough distance for a sufficient amount of time.

This illustrates how mathematical models which aim to explain collective animal behaviour and synchronisation, such as between starlings, can benefit from an understanding of the underlying mechanisms. An ORDER system between S1 and S2 is a dynamic and adaptable system. Their flexibility and responsiveness to each other, as well as other environmental influences, cannot be *fully* captured by a mathematical formula. In Chapter 4, Section 1.2, Nishida will be shown to argue this very point, and how, in the case of humans, intention is an important variable that many studies looking at entrainment omit.

2.2 Entrainment Between Four Starlings

Let us now add a third (S3) and fourth (S4) starling, taking all of the above and once again multiplying it by two. Just like S1 and S2, when S3 and S4 rhythmically beat their wings, they too generate convection currents and patterns of air. These generated patterns of air can have a significant effect on the advection between all four starlings, as well as with the surrounding air, provided that is, S1, S2, S3, and S4 are at a sufficient enough distance for a sufficient amount of time.

As each starling rhythmically beats their wings, each transfers kinetic energy to the surrounding air molecules, thereby generating patterns of air and convection currents. As these patterns and currents of air propagate away from one starling, they can subtly alter how the remining three beat their wings by way of advection. As this process continues, the

frequencies of S1, S2, S3, and S4's rhythmic wing beats become increasingly synchronised, in the sense that the advection currents generated subtly shape how each individual starling rhythmically beats its wings relative to the other.

It might be helpful to think of each individual starling as a kind of air pattern generator. In flight, the rhythmic beating of their wings generates a trailing bubble of convection currents around themselves and in their wake. As the bubbles created by each starling overlap, the advection of each starling is subtly altered. Like all other energy systems, this coupling eventually ends, be it in response to a predator, a gentle breeze, or many of the other factors. Thus, in principle, S1, S2, S3, and S4 can form an ORDER system, provided that all four are at a sufficient enough distance, for a sufficient amount of time.

Consider now if S1 and S4 were not at a sufficient distance to form an ORDER system directly, meaning that the generated patterns of air from each dissipated before having a significant effect on each other. In this case, S2 and S3 can provide an intermediary energy system. S1 and S2 are an ORDER system, as are S3 and S4. If S2 and S3 are at a sufficient distance from each other, then another ORDER system is created. This ORDER system includes and transcends all four starlings, in the sense that what each can and will do is shaped by the others. Thus, like the wall between P1 and P2, S2 and S3 can evoke an ORDER system between S1 and S4 by way of convection and advection, even when S1 and S4 are not at a sufficient distance to directly effect each other.

2.3 Entrainment Within a Murmuration

A murmuration of starlings is a spectacular sight to behold. It involves hundreds, sometimes tens of thousands, of starlings flying in an extraordinarily complex and organised formations. Waves of movement and apparent order ripple throughout the murmuration. Patterns emerge and dissipate. There is a visible ebb and flow to a murmuration, with birds

moving together with an almost liquid-like fluidity. Why does a murmuration occur? While there are several different theories that attempt to explain why, mostly to do with warding off predators, the true answer is that we simply do not know.[276] How does a murmuration occur? Often speculated to involve some form of hidden communication or behavioural contagion between birds,[277] this being a kind of "neighbourhood theory" of correlation,[278] the answer is, once again, that we are not entirely sure how a murmuration actually takes place. Therefore, while there are many theories about how and why a murmuration occurs, the underlying motivations and mechanisms remain largely enigmatic.

That said, a murmuration is partially that of coordination, order, and synchronisation, where thousands of individual starlings show an ability to fly in an extremely complex and relatively organised formations. Tellingly, statistical models looking at the mechanics of bird flight, created by Bialek et al., found that

> local, pairwise interactions between birds are sufficient to correctly predict the propagation of order throughout entire flocks of starlings. [And] the effective interactions among birds are local and that the number of interacting neighbors is independent of flock density, confirming that interactions are ruled by topological rather than metric distance.[279]

Simply put, Bialek et al.'s models found that the collective behaviour of a murmuration could be accurately predicted by looking at the interactions between individual birds. This indicates that the previously mentioned transitivity, where four starlings are caught up in an ORDER

[276] Andrew J. King, and David J. T. Sumpter (2012). Murmurations, *Current Biology*. 22(4), p.R112.
[277] Sara Brin Rosenthala, Colin R. Twomey, Andrew T. Hartnett, Hai Shan Wu, and Iain D. Couzin. (2015). Revealing the Hidden Networks of Interaction in Mobile Animal Groups Allows Prediction of Complex Behavioral Contagion, *Proceedings of the National Academy of Sciences – PNAS*.112(15), pp.4690 – 4695.
[278] Andrea Cavagna, Alessio Cimarelli, Irene Giardina, Giorgio Parisi, Raffaele Santagati, Fabio Stefanini, Massimiliano Viale (2010). Scale-free Correlations in Bird Flocks, *PNAS*. 102(26), pp.11865 – 11870.
[279] Bialek et al. (2012; 2011). *Statistical Mechanics for Natural Flocks of Birds*. p.4786.

system that both includes and transcends them, can offer a way to understand the organised and collective activity of the murmuration as a whole.

Moreover, Bialek et al. also found that physical distance was less important than the relative distance between birds, in the sense that starlings which were further apart often affected each other in more significant way than those that were relatively closer. While there may be a "social" force or mechanism to this, Bialek et al. posit that '[g]iven the success of the model in predicting the propagation of order throughout the flock, it is interesting to ask whether we can take this mechanistic interpretation seriously.' [280]

The success of Bialek et al.'s statistical models in predicting the propagation of order within a murmuration could be attributed to the fact that, as we saw, individual starlings are part of an ORDER system which propagates throughout the murmuration. Once again, it might be helpful to think of each individual starling as an air pattern generator, and likewise for the ORDER system of S1, S2, S3, and S4 combined. In flight, all four starlings generate a trailing bubble of convection currents around themselves and in their wake.

Let us now add another ORDER system, comprised of a fifth (S5), sixth (S6), seventh (S7), and eighth (S8) starling, combined. This second ORDER system also generates a trailing bubble of convection currents around it and in its wake. It alters the advection of individual starlings within, as well as other bubbles of convection currents, such as the initial ORDER system of S1, S2, S3, and S4. In this way, both ORDER systems, as well as their constitute starlings, are affected by each other in significant way. Furthermore, like S1 and S4, S1 and S8 can be part of an ORDER system even if, as Bialek et al.'s models show, 'interactions are ruled by topological rather than metric distance.'[281] Thus, in this example, S1

[280] Bialek et al. (2012; 2011). *Statistical Mechanics for Natural Flocks of Birds*. p.4788.
[281] Ibid. p.4786.

and S8 are part of an ORDER system, being connected by their shared ETMs with S2, S3, S4, S5, S6, and S7.

The complexity of such ORDER systems is exponentially increased relative to the amount of starlings. More so when considering that a murmuration can involve tens of thousands of birds. Nonetheless, understood as an ORDER system, it can be surmised that, whether it is S1 or S10,000, the individual behaviour of a starling generates patterns of air and convection currents that both shape and get shaped by the behaviour of the murmuration as a whole. Thus, the ORDER system of a murmuration both includes and transcends the individual behaviour of individual starlings.

2.4 Secondary Features

The example of a murmuration highlights some secondary features that shall be important for later discussions. Consider a single starling (S9) entering a murmuration for the first time. Upon doing so, S9 is caught up in an ORDER system that immediately affects its behaviour. A murmuration also functions as an air pattern generator. As a whole, it generates a trailing bubble of convection currents around and in its wake, shaping the behaviour of all individual starlings caught up in it. Accordingly, when S9 initially enters the murmuration, its own bubble of convection both shapes and gets shaped by the ORDER system as a whole. In other words, S9 gets caught up in a process of entrainment that shapes and organises what it can and will do.

There are two ways of understanding this: from the top down and from the bottom up. From the top down, a murmuration shapes the behaviour of S9, as the energy transferred by the ORDER system as a whole alters the behaviour of an individual starling caught up in it for the first time. This is a form of downward entrainment, where individual starlings behave differently in the murmuration as a whole. Conversely, from the bottom up, the behaviour of

S9 also shapes the murmuration, as the energy transferred by the individual starling alters the ORDER system as a whole. This is a form of upward entrainment, where the murmuration as a whole behaves differently because of the behaviour of individual starlings. To put it another way, downward entrainment from the murmuration "pulls up" the behaviour of S9, while upward entrainment from S9 "pulls down" the behaviour of the murmuration as a whole. Like P1 and P2, which increase and decrease their oscillations relative to each other until a shared frequency emerges, the behaviour of S9 and of the murmuration are altered relative to each other. This once again exemplifies Gillett's novel theory of emergentism, where the actions of the parts, in this case individual starlings, and the actions of the whole, in this case the murmuration, are mutually organised.

Consider the opposite scenario, where a single starling (S10) exits a murmuration. Upon doing so, it is immediately decoupled from an ORDER system that shaped much of its behaviour. There is no longer an energy transfer between. However, even in the absence of S10, the emergent frequency of the murmuration persists. This is similar to how, in the example Huygens' entrained pendula, P1 will continue to oscillate at the same emergent frequency even if P2 is removed from the wall and no longer part of the system. Likewise, when S10 decouples from the murmuration, the emergent frequency of the ORDER system as a whole continues. As such, upward and downward entrainment mean that a murmuration both includes and transcends the individual starlings caught up in it.

This is similar to contemporary discussions of emergence. Paul Humphreys, for example, argues in *Emergence: A Philosophical Account* that 'flock grouping results from the interactions between individual birds, its cohesion is a novel feature of the aggregate collection of birds, and that cohesion is a holistic aspect of the flock that cannot be possessed

by individual members.'[282] Put another way, the flock or murmuration has emergent patterns or features that cannot be explained to, or explained by, any individual bird. This kind of emergentism holds that the murmuration as a whole cannot be reduced to the behaviour of its individual parts. In short, the murmuration as a whole is more than the sum of its parts.

In *Reduction and Emergence in Science and Philosophy*, Gillett argues that it is also the case that '[p]arts behave differently in wholes.'[283] For Gillett, the dichotomy between emergentism and reductionism is a false one. Instead, he posits a syntheses of the two, arguing:

> A Strongly emergent nature is Mutualist and hence has *two* sources of determinativity, […] with both the productive determination of components within their own lower level and the "upward" determination of their compositional relations, but also the productive determination of Strongly emergent composed entities at their higher level and their "downward" machretic determination.[284]

Machretic determination, or "machresis," is Gillett's novel term. It combines the word "macro," derived from the Greek word "*makros*," meaning large or long, with the Greek word "*chresis*," meaning use or usage. In the context of a murmuration, machresis is when the murmuration as a whole shapes the behaviour of individual starlings, just as individual starlings shape the behaviour of the murmuration as a whole.

However, Karen Crowther notes that for a book interested in reductionism and emergentism in science Gillett rarely uses any examples from science to support his

[282] Paul Humphreys (2016). *Emergence: A Philosophical Account*. New York, United States of America; Oxford University Press. pp.45 – 46
[283] Gillett (2016). *Reduction and Emergence*. p.201.
[284] Ibid. p.234..

argument.[285] Instead, Gillett uses a number of thought experiments. While this does not necessarily detract from his position, Crowther's critique will be addressed in Chapter 3, using examples of upward or downward entrainment in science to show how, in an ORDER system '[w]holes are more than the sum of their parts'[286] and '[p]arts behave differently in wholes.'[287]

2.5 Summary and Context

In summary, a murmuration exemplifies how entrainment in the biological world is considerably more complex than in the material world. It demonstrates how animals, bacteria, fungi, plants, and single celled organisms are all subject to the ETMs of conduction, radiation, convection, and advection, as well the ORDER system of entrainment. It also shows how, within an ORDER system, '[w]holes are more than the sum of their parts'[288] and that '[p]arts behave differently in wholes.'[289] This is upward and downward entrainment, where wholes "pull up" the behaviour their parts and parts "pull down" the behaviour of wholes. Entrainment is both from the top down and from the bottom up, as the emergent period of synchronisation between parts is relative to each other and the ORDER system as a whole.

Evidently, this goes far beyond a murmuration of starlings. A school of herrings, a stampede of horses, a swarm of insects, a crowd or "sea of people," all can be potentially understood as an ORDER system wherein the ETM shared between lifeforms initiate and sustain periods of synchronisation. Entrainment has been identified with many other animals, ourselves included. Experiments with parrots, sea lions, elephants, cetaceans, horses,

[285] Karen Crowther (2018). Review: Reduction and Emergence in Science and Philosophy, *Philosophy*. 93(4). pp.586 – 590.
[286] Gillett (2016). *Reduction and Emergence*. p.201.
[287] Ibid. p.201.
[288] Ibid. p.201.
[289] Ibid. p.201.

primates, and many others,[290] all indicate that living organisms have the capacity to entrain with each other and their environments. Thus, while the ETMs may differ, the underlying process of entrainment in the biological and material world remains the same.

In context, the phenomenon of entrainment once again exemplifies Nishida and Noë's world of action and organisation, only this time in the material and biological realms. A murmuration, understood as an ORDER system, is initiated and sustained within the material and biological world, with the generated convection currents and patterns of air having a significant effect on the advection between individual starlings, the surrounding air, and the murmuration as a whole. An ORDER system, as modelled here, illustrates a process where the behaviour of parts organises the system as a whole which, in turn, organises the behaviour of its parts. Thus, entrainment emerges as part of the world of action and organisation, involving a dynamic process where wholes and parts both shape and are shaped by each other.

In Chapter 3, Section 1, a similar explanatory model will be used to provide a conceptual framework for understanding the complexities of the human brain, as well as the phenomenon of neural entrainment. Like a single starling in a murmuration, a single neuron is caught up in a process where wholes and parts both shape and are shaped by each other. The electrical activity of individual neurons organise the collective electrical activity of the brain which, in turn, organises the electrical activity of individual neurons. In Chapter 3, Sections 2 and 3, this will be expanded upon to show how our sensorineural and sensorimotor systems also evoke periods of entrainment between our brains, bodies, and perceived environment, including other people. This will further exemplify Nishida and Noë's world of action and organisation in the material, biological, and sociohistorical world, wherein we are

[290] Margaret Wilson, and Peter F. Cook (2016). Rhythmic Entrainment: Why Humans Want to, Fireflies Can't Help it, Pet Birds try, and Sea Lions Have to be Bribed, *Psychonomic Bulletin & Review*. 23(6), pp.1647 – 1648.

neuroecologically entrained, and, as will be shown in Chapter 4, wherein the artist can intentionally use spontaneous entrainment to shape the world which, in turn, shapes what we are: an aesthetic phenomenon.

Section 3: Entrainment in the Sociohistorical World

Like pendula and starlings, humans are open energy systems, having the ability to entrain with each other and their surroundings by the transfer of energy between. Humans, therefore, are subject to the very same mechanisms found in the biological and material world. However, unlike pendula, and possibly starlings, humans are also social and historical animals. We have complex social lives that arise from our collective and shared history. We create, or possibly discover, all manner of social objects, both abstract and concrete. And, reciprocally, these objects shape and create us. Humans, it is often argued, are not mindless automatons caught up in the processes and mechanisms of the world around us.

Through their brains, bodies, and nervous systems, which grant the ability to act in and perceive their surroundings, humans are equipped to both couple and decouple with the ETMs offered by their environments. This, of course, does not mean that humans are more than their material and biological bodies; our neurobiology is as much a part of the material and biological world as the rest of us. Accordingly, the sociohistorical world is both material and biological. It is the world wherein humans act and are acted upon by ETMs and are subject to the laws and of thermodynamics and fluid dynamics, as well as the ORDER systems of entrainment. Thus, to understand entrainment in the sociohistorical world, let us look at a well document and real-world example: The London Millennium Footbridge (Millennium Bridge).

3.1 The Millennium Bridge and One Pedestrian

On June 10th, 2000, the Millennium Bridge opened to pedestrians. On the day, Londoners turned out in the hundreds, excited to be one of the first to walk across this suspension bridge. However, as pedestrians walked across, it was soon noticed that the bridge begun to gently sway. While subtle at first, the frequency and amplitude of swaying continued to increase as the day went on. Thankfully, organisers soon recognised where this might be heading and closed the bridge before it escalated to catastrophic results. To understand what happened here, let us examine each of the contributing factors, starting with a single pedestrian walking.

A single walker (W1) transfers and absorbs energy to and from their environment. They radiate thermal energy, as well as absorbing radiated energy from, for example, the sun. As W1 moves, they also generate patterns of air by way of convective and advective processes, much in the same way as S1 does. However, while the energy radiated, converted, and advected by W1 does get absorbed by their surroundings, this is unlikely to have had a noticeable effect once they stepped on to the Millennium Bridge. This is because the energy transferred is relatively insignificant. Thus, radiation, convection, and advection, while present, did not transfer enough between W1 and the bridge to have a significant effect.

What did have a significant effect was the ETM of conduction. As W1 walks, their feet transfer kinetic energy to the ground by way of conduction. This conducted energy then makes the ground subtly vibrate. Similar to the seismic waves of earthquakes, though to a far lesser degree, vibrations propagate through the solid materials like soil, rocks, and minerals. This propagation of energy is also affected by what W1 is walking on. Soft soil, for instance, absorbs and dissipates much of the energy conducted by way of compression. A hard rock, in contrast, does not compress, meaning that the conducted energy is transferred more directly. If W1 steps on a hard rock that is placed on soft soil, the rock transfers energy from their foot

into the soil, which in turn compresses and absorbs a significant amount of the energy conducted. The relevant point here is that when W1 first stepped on to the Millennium Bridge, each one of their footsteps transferred kinetic energy to the bridge, causing the bridge to subtly vibrate with each step.

Another important factor was that W1, like all humans, has a natural walking pattern or gait. When humans walk, we do so, as they say, one step at a time. The timing between our footsteps, while not constant in the same way as, say, Huygens' two pendula, falls within a natural rhythm. In the ontological sense, this rhythm is the recurring, periodic, and oscillating pattern of humans' natural gait, being, as a Simons previously explained, 'a property, not a substance.'[291]

It is uncommon, although possible, to see people walk by stepping forward with their left foot three times, then their right foot once, then their left foot twice, then their right foot three times. Likewise, it is uncommon to see people walk two steps, stop, take three steps back, then one step to the side, and then two steps forward. For lack of a better word, walking like this is just strange. In fact, as we will see in Chapter 4, Section 3.2, this is exactly the kind of strangeness that many performance artists look for. Nevertheless, for the moment, walking like this is strange because W1's gait falls within a natural frequency. This is, in part, due to the fact that human physiology and musculoskeletal structures fall within a certain range. While this may differ from person to person, as well as with age, no human can, for example, walk or run faster than 10 kilometres per hour, nor can they do so with a stride longer than five feet unaided, and so forth.

Additionally, strong correlations have been found between rhythmic perception and gait patterns, with numerous studies showing how 'motor training while listening to constant

[291] Simons (2019). *The Ontology of Rhythm*. p.63.

rhythm, is associated with coupling between movement and rhythm, and that practicing walking with constant rhythm, is associated with changing gait variability, step symmetry, walking velocity, walking cadence and step length.'[292] Simply put, humans appear to have a tendency to synchronise their gait with perceived rhythms, often spontaneously.

So strong is this tendency that rhythmic beats are often used as a way of both diagnosing and rehabilitating neurobiological disorders like Parkinson's and Huntington's disease, as well as Amyotrophic Lateral Sclerosis and many more.[293] One study, by Koganemaru et al., found that 'rhythmic transcranial brain stimulation over the cerebellum could alter walking rhythm. [Indicating] a significant entrainment of gait rhythm compared with the control conditions.'[294] While such experiments are by no means conclusive, at best showing a strong correlation, they highlight how the perceived rhythms of the world around us can affect or movements. As such, when W1 walks, the perceived rhythm of their steps, both physical and auditory, can affect the rhythm of their walking pattern, thereby creating as kind of sensorimotor feedback loop that increases the synchronisation of their steps.

This kind of sensorineural and sensorimotor entrainment will be discussed at length in Chapter 3, Sections 2 and 3, where scientific studies will be shown to highlight the emergent synchronisation between humans and a perceived environment that includes other people. In Chapter 4, Section 2.2, we will further explore this human tendency to spontaneously

[292] Maayan Schweizer, Sharon Eylon, and Michal Katz-Leurer (2020). The Correlation Between Rhythm Perception and Gait Characteristics at Different Rhythms Among Children with Cerebral Palsy and Typically Developing Children, *Gait & Posture*. 82, p.83.

[293] Aidin Ashoori, David M. Eagleman, and Joseph Jankovic (2015). Effects of Auditory Rhythm and Music on Gait Disturbances in Parkinson's Disease, *Frontiers in Neurology*. 6, pp.234 – 234;
Alessandro Mengarelli, Andrea Tigrini, Sandro Fioretti, and Federica Verdini (2022). Identification of Neurodegenerative Diseases from Gait Rhythm Through Time Domain and Time-dependent Spectral Descriptors, *IEEE Journal of Biomedical and Health Informatics*. 26(12), pp.5974 – 5982; and
Linda Rennie, Arve Opheim, Espen Dietrichs, Niklas Löfgren, and Erika Franzén (2021). Highly Challenging Balance and Gait Training for Individuals with Parkinson's Disease Improves Pace, Rhythm and Variability Domains of Gait – A Secondary Analysis from a Randomized Controlled Trial, *Clinical rehabilitation*. 35(2), pp.200 – 212.

[294] Satoko Koganemaru, Yusuke Mikami, Masao Matsuhashi, Dennis Q. Truong, Marom Bikson, Kenji Kansaku, and Tatsuya Mima (2020). Cerebellar Transcranial Alternating Current Stimulation Modulates Human Gait Rhythm, *Neuroscience Research*. 156, p.265.

synchronise gait, as it exemplifies the resonance between material, biological, and sociohistorical processes, as well as how ETMs alone cannot *fully* capture the complex entanglement of our social and historical existence, and how this shapes our walking style.

For the moment, it can be said that when W1 stepped onto the Millennium Bridge their walking pattern generated a rhythmic transfer of energy to the bridge. This was, in part, driven by the natural variation in human physiology and musculoskeletal structures, as well as the human tendency to synchronise their gait with perceived rhythms.

However, while conduction did have a more significant effect than the other ETMs, due the asymmetry of mass and energy between W1 and the bridge, this is still unlikely to have had a significant or noticeable effect on the behaviour of either. Yet, when W1 stepped on to the Millennium Bridge, their footsteps rhythmically transferred kinetic energy to the bridge, causing it to vibrate in an ever so subtle and, notably, rhythmic fashion.

3.2 The Millennium Bridge and Two Pedestrians

As we did in the previous explanatory model, let us now take the above and multiply it by two. Like W1, when a second walker (W2) steps on to the bridge, their footsteps also rhythmically transferred kinetic energy, causing the bridge to vibrate in a subtle and rhythmic fashion. Like W1, the gait of W2 also falls within the natural variation and frequency, meaning that the walking patterns of W1 and W2 were synchronised to the extent that they were both confined to the limitations of human physiology and musculoskeletal structures. Like W1, W2 also has the tendency to synchronise their walking patterns to perceived rhythms. While, for both, this can create a kind of sensorimotor feedback loop that increases the synchronisation of their steps, they also can perceive each other, be it visually, auditorily, or physically.

It is a well-recognised phenomenon that people walking together often match steps with each other,[295] and that complete strangers can often be seen to match their speed and stride. This is particularly noticeable in gyms, where it is quite common to see rows of complete strangers running in synchronisation on treadmills. While it remains to be conclusively determined if this is anything more than a tendency, Bruno H. Repp and Yi-Huang Su speculate that this is, in fact, 'a tendency to entrain to each other's movements on the basis of perceptual information that they receive.'[296] While it has yet to be seen if the phenomenon of entrainment is at play here (more on this in Chapter 3, Sections 2 and 3, as well as Chapter 4, Section 2), W1 and W2, like all humans, have a tendency to synchronise their steps with each other when walking. As such, the generated walking patterns of both W1 and W2 were synchronised to the extent that they fell within the natural variation of humans, as well as both having the tendency to synchronise their steps, be it intentionally or otherwise.

Consequently, when W1 and W2 stepped on to the Millennium Bridge in 2000, they generated increasingly synchronised walking patterns that rhythmically conducted energy to the bridge. The natural variation and frequency of human physiology and musculoskeletal structures, combined with the human tendency to synchronise their gait with perceived rhythms, provided a rhythmic transfer of energy from W1 and W2 to the bridge. Once again, due the asymmetry of mass and energy between just two pedestrians and the Millennium Bridge, this is unlikely to have had a significant effect on the behaviour of either, as the mass and energy of the bridge is far greater than the combined mass and energy of W1 and W2. Nevertheless, when W1 and W2 stepped on to the Millennium Bridge, their increasingly

[295] Bruno H. Repp and Yi-Huang Su (2013). Sensorimotor Synchronization: A Review of Recent Research (2006–2012), *Psychonomic Bulletin & Review*. 20(3), p.429.
[296] Repp, and Su (2013). *Sensorimotor Synchronization*. p.431.

synchronised footsteps rhythmically transferred kinetic energy to the bridge, causing it to vibrate in a slightly less subtle and rhythmic fashion.

3.3 The Millennium Bridge and a Group of Pedestrians

Let us now add a third (W3), fourth (W4), and fifth (W5) walker. As each stepped on to the bridge, their footsteps also rhythmically transferred kinetic energy, causing the bridge to vibrate in a rhythmic fashion. Once again, the asymmetry of mass and energy means that this is unlikely to have had a significant effect on the bridge, given that the mass and energy of the bridge is far greater than even five pedestrians. As people continued to step on to the bridge, at some point, perhaps when, as Strogatz et al. noted, 'the crowd reaches a critical size,'[297] the mass and energy of the pedestrians crossing the Millennium Bridge was sufficient to have a significant effect. A crowd of two hundred walking pedestrians, for example, transfers a considerable amount of energy to the bridge by way of conduction.

Accordingly, the energy conducted to the bridge increases relative to the mass and energy of walking pedestrians. Furthermore, due to the natural variation and frequency of human physiology, as well as the human tendency to synchronise their gait with each other and with perceived rhythms, the propagating and rhythmic energy transferred by a large crowd of walking pedestrians no longer had a subtle effect on the Millennium Bridge in 2000; it started to sway.

3.4 The Swaying Millennium Bridge

Like pedestrians, the Millennium Bridge is also an open system. It has the ability to both transfer and absorb energy from its surroundings. It radiates energy, as does it absorb radiated energy. Being a suspension bridge, the ETMs of convection and advection also have a significant affect. On a windy day, for example, patterns of air transfer energy to the bridge,

[297] Steven H. Strogatz, Daniel M. Abrams, Allan McRobie, Bruno Eckhardt, and Edward Ott (2005). Theoretical Mechanics: Crowd Synchrony on the Millennium Bridge, *Nature*. 438(7064), p.43.

making it sway. When the bridge sways, it too generates patterns of air by way of convection and advection. In fact, most suspension bridges, the Millennium Bridge included, are designed to accommodate for this very thing.

However, while radiation, convection, and advection were present on its opening day, they did not transfer enough energy between the bridge and its surrounding to have a significant or noticeable effect. This is because it was a particularly sunny day, for London, when the bridge first opened to the public, with little to no wind. Which might explain why a large crowd of people turned up.

Nevertheless, when the Millennium Bridge started to sway, this conducted energy to pedestrians walking across. This conducted energy, originating from the swaying motion of the bridge, rhythmically transferred energy from the bridge to pedestrians. Just like how individual pedestrians' footsteps rhythmically transferred energy to the bridge, the bridge's swaying motion rhythmically transferred energy to the pedestrians. As a result, pedestrians were forced to further synchronise their footsteps with each other and, crucially, with the swaying motion of the bridge. More specifically, pedestrians were forced to redistribute their weight so as to maintain balance on the swaying bridge. The dynamic and postural balance of humans, being a kind of unconscious sensorimotor ability we learn as a child and lose with age,[298] as Steiner et al. note, is an ability which 'play[s] a crucial role in everyday activities such as standing and walking, especially on uneven ground. Adaptation to altered support conditions requires complex coordination of trunk and multi-joint leg and arm movements.'[299] Particular to the Millennium Bridge, this means that pedestrians needed to redistribute their

[298] David A. Wilson, Simon Brown, Paul E. Muckelt, Martin B. Warner, Sandra Agyapong-Badu, Roger A. Hawkes, Andrew D. Murray, and Maria Stokes (2022). Testing Muscle Strength and Dynamic Balance in Older Recreational Golfers and Healthy Sedentary Non-golfers in Community Settings, *European Journal of Public Health*. 32(Supplement 2), p.ii84.

[299] Katharina Marie Steiner, Anne Enders, Wiebke Thier, Giorgi Batsikadze, Nicolas Ludolph, Winfried Ilg, and Dagmar Timmann (2016). Cerebellar tDCS does not Improve Learning in a Complex Whole Body Dynamic Balance Task in Young Healthy Subjects, *PloS One*. 11(9), pp.1 – 2.

weight, either intentionally or spontaneously, in order to maintain balance. When walking, this directly affected the pedestrians' walking patterns, making them all walk in a synchronised and swaying manner. As such, when the crowd walked across the swaying Millennium Bridge, the rhythmic motions of the bridge conducted energy to them, thereby generating new and synchronised walking patterns.

Putting all of this together, it can thus be said that pedestrians and the Millennium Bridge were caught up in an ORDER system The transfer of energy between spontaneously initiated and sustained a period of emergent synchronisation. The energy conducted by the synchronised walking patterns of pedestrians initiated and increased the swaying motion of the Millennium Bridge. The energy conducted by the swaying motion of the Millennium Bridge initiated and increased the synchronised walking patterns of pedestrians. This means that pedestrians had to walk in a very specific and synchronised gait if they wanted to stay afoot. While a minor adjustment a first, the more pedestrians synchronised their gait, the more the bridge swayed and wobbled. The more the bridge swayed and wobbled, the more pedestrians needed to synchronise their gait. And so on.

In this way, as Strogatz et al. explain, 'wobbling and synchrony are inseparable. They emerge together, as dual aspects of a single instability mechanism.'[300] In other words, pedestrians and bridge were caught up in an ORDER system, where the behaviour of one increasingly affected the behaviour of the other. The swaying motion of the Millennium Bridge increased the synchronised walking patterns of pedestrians which, in turn, increased the swaying motion of the Millennium Bridge, and so on. Thus, as the entrainment between pedestrians and bridge continued, there was a period of emergent synchronisation between all.

[300] Strogatz et al. (2005). *Theoretical Mechanics.* p.43.

3.5 Secondary Features

Consider now a sixth walker (W6) stepping onto the already swaying Millennium Bridge for the first time. Like a starling getting caught up in a murmuration, W6 is immediately caught up in an ORDER system that affects their walking pattern, as does their walking pattern affect the swaying motion of the bridge. When W6 steps on to the bridge, they both transfer and absorb conducted energy. Their footsteps both shape and get shaped by the ORDER system as a whole. Accordingly, W6 gets caught up in a process of entrainment that has a significant effect on what they can and will do.

From the bottom up, the behaviour of W6 shapes the swaying bridge. The energy transferred by their individual footsteps alters the ORDER system as a whole. This is upward entrainment, where the swaying bridge behaves differently because of the individual pedestrian. From the top down, the swaying bridge also shapes the behaviour of W6. The energy transferred by the ORDER system as a whole alters the behaviour of the individual pedestrian caught up in it for the first time. This is downward entrainment, where the individual pedestrian behaves differently on a swaying bridge. Downward entrainment "pulled up" the behaviour of W6, while upward entrainment "pulled down" the behaviour of the swaying bridge. Like P1 and P2, this process increases and decreases until a shared frequency is found. Thus, the rhythmic motions of W6 and of the bridge are altered relative to each other.

Consider now the exact opposite scenario, where a seventh walker (W7) intentionally steps off of the swaying Millennium Bridge. Upon doing so, W7 is immediately decoupled from the ORDER system that was affecting their walking pattern. There is no longer a transfer of energy between them. However, without W7, the emergent swaying motion of the bridge persists, being able to downwardly entrain any other pedestrian who decides to cross, as well as sustaining the entrainment with the remaining pedestrians. This is similar to how

an entrained pendulum, P1, continues to oscillate at the same emergent frequency even when P2 is removed. It is also similar to how the behaviour of a murmuration, as a whole, continues even without an individual starling. Likewise, when W7 decouples from the swaying Millennium Bridge, the emergent frequency of the ORDER system, as exemplified by both its swaying motion and synchronised walking patterns of pedestrian, continues. As pedestrians continued to step off of the swaying bridge, the dissipation of energy increased. At some point, the energy transferred was insufficient to sustain an ORDER system, thereby ending the synchronisation and averting a catastrophe like the collapse of the Tacoma Narrows Bridge some 60 years earlier. Therefore, the swaying Millennium Bridge is an ORDER system that both includes and transcends the individual pedestrians caught up in it, with the ETM of conduction initiating and sustaining a period of emergent synchronisation.

3.6 Entrainment is not just Synchronisation

As should be evident by now, entrainment is not merely synchronisation. While an ORDER system does involve a period of emergent synchronisation, this is very different from saying that entrainment is equivalent to synchronisation. This is an important distinction to highlight, and one that will be particularly problematic in the Chapter 3, Sections 2 and 3, as the two terms are often used synonymously within the literature on entrainment.

For instance, in a short paper titled 'Theoretical Mechanics: Crowd Synchrony on the Millennium Bridge,'[301] Strogatz et al. offer a mathematical model to explain the previous example. However, not once is the word "entrainment" used, with authors choosing to use terms like 'collective synchronization'[302] and 'crowd-synchronization dynamics'[303] instead. Three years after the publication of their paper, Steven Strogatz gave a TED talk, titled 'How

[301] Strogatz et al. (2005). *Theoretical Mechanics.* p.43.
[302] Ibid. p.43.
[303] Ibid. p.43.

Things in Nature Tend to Sync Up,'[304] discussing, among many others, the emergent synchronisation between metronomes, within a murmuration, and between crowds of people and the Millenium Bridge. Close to 25 minutes in length, not once is the word "entrainment" used by Strogatz. This is not to say that the mathematical models created by Strogatz and his colleagues are wrong, nor is their use of the word "synchronisation" wrong *per se*, only that by referring to the phenomenon of entrainment as merely synchronisation misses the underlying mechanisms.

In the aptly titled paper, 'Entrainment is NOT Synchronization,'[305] Eric L. Bittman gives a simple yet revealing example: 'If I see someone shooting at me, I duck—hopefully simultaneously or nearly so. Although neither the act of shooting nor the act of ducking is controlled by an oscillator, they occur at the same time, that is, they are synchronized.'[306] What Bittman's example shows is that synchronisation can happen without entrainment. Synchronisation can be mere happenstance.

In the example of P1 and P2, the oscillations of both pendula could be synchronised even if they were placed in two sperate rooms with no shared ETMs. Likewise, in the example of S1 and S2, the beating both starlings' wings, as well the generated patterns of air, can also be synchronised without any energy transferred between. As is the case with pedestrians crossing the Millennium Bridge. The walking patterns of W1, W2, W3, and so on, can all be synchronised without any energy transferred between either pedestrians or the bridge. In short, synchronisation can happen without entrainment. While synchronisation is an emergent property of entrainment, entrainment is not merely synchronisation.

[304] TED (2008). Steven Strogatz: How Things in Nature Tend to Sync Up, *YouTube*.
[305] Eric L. Bittman (2021; 2020). Entrainment is NOT Synchronization: An Important Distinction and its Implications, *Journal of Biological Rhythms*. 36(2), Title.
[306] Bittman (2021). *Entrainment is NOT Synchronization*. pp.196 – 199.

While a subtle difference, this will be important one going forward. Its importance comes from the fact that using the words “entrainment” and “synchronisation” synonymously opens the door to all manner of dubious claims. Especially when it comes to humans. New age and pseudoscientific medical practices often claim to provide ways of synchronising ourselves with the “healing vibrations” and “healing energies” of crystals, sound baths, flashing lights, and so on. Similarly, astrologers often assert the ability to extract truths and predictions from the synchronisation of humans with celestial bodies, be they astronomical or heavenly. In recent years, practitioners of so called “quantum entrainment” attribute all manner of benefits and harms to the purported misalignment of our energies with quantum particles, and so on. In Chapter 3, Section 3.3, this will be particularly noticeable in scientific studies looking at interpersonal and purported intentional entrainment, as they will be shown to often conflate intentional synchronisation with spontaneous entrainment.

This highlights the importance of distinguishing between entrainment and synchronisation. Synchronisation is not entrainment. Entrainment is not just synchronisation. Entrainment and synchronisation are not equivalent. This is because the phenomenon of entrainment is an ORDER system that necessarily requires ETMs between two or more systems, whereas synchronisation is not. Synchronisation is an emergent property of entrainment. Therefore, while entrainment does imply synchronisation, synchronisation does not imply entrainment. In short, entrainment is not merely synchronisation.

3.7 Summary and Context

The Millennium Bridge, understood as an ORDER system, exemplifies how humans can entrain with each other and their surroundings. It highlights how ORDER systems in the sociohistorical world both transcend and include the individual actions and behaviours of humans, and how material and biological processes are entangled in social and historical contexts. In this way, as we saw with a murmuration, ‘[w]holes are more than the sum of

their parts'[307] and '[p]arts behave differently in wholes.'[308] In short, sociohistorical entrainment can be from the top down and from the bottom up. This goes far beyond the Millennium Bridge. It is the reason why the Tacoma Narrows Bridge famously collapsed in 1940, and the reason why many militaries require soldiers to break step when marching across such suspension bridges.

The Millennium Bridge exemplifies, more generally, the myriad of ways that humans can entrain with and within the sociohistorical, and how the transfer of energy between can directly shape what we can and will do. Circadian rhythms,[309] rhythmic entrainment,[310] ecological entrainment,[311] neural and neurobiological entrainment,[312] sensorimotor entrainment,[313] all can be potentially understood as overlapping ORDER systems that both include and transcend the individual, as we will see in the following chapters. Whenever the ETMs shared between humans and their surroundings initiate and sustain a period of emergent synchronisation, there is always the potential for ORDER. While the ETMs may differ, the underlying process of entrainment in the sociohistorical world remains the same as in that shown in the biological and material.

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[307] Gillett (2016). *Reduction and Emergence*. p.201.
[308] Ibid. p.201.
[309] Ute Abraham, Adrián E. Granada, Pål O. Westermark, Markus Heine, Achim Kramer, and Hanspeter Herzel (2010). Coupling Governs Entrainment Range of Circadian Clocks, *Molecular Systems Biology*. 6(438), pp. 1 – 13; and Charles A. Czeisler, Gary S. Richardson, Janet C. Zimmerman, Martin C. Moore-Ede, Elliot D. Weitzman (1981). Entrainment of Human Circadian Rhythms by Light-dark Cycles: A Reassessment, *Photochemistry and Photobiology*. 34(2), p.240.
[310] Merker et al. (2009). *On the Role and Origin of Isochrony in Human Rhythmic Entrainment*. pp.4 – 17.
[311] Jessica Phillips-Silver, Athena Aktipis, and Gregory A. Bryant (2010). The Ecology of Entrainment: Foundations of Coordinated Rhythmic Movement, *Music Perception*. 28(1), pp.3 – 14
[312] Daniel Calderone, Peter Lakatos, Pamela D. Butler, and F. Xavier Castellanos (2014). Entrainment of Neural Oscillations as a Modifiable Substrate of Attention, *Trends in Cognitive Sciences*. 18(6), pp.300 – 309; and Laura K. Cirelli, Christina Spinelli, Sylvie Nozaradan, and Laurel J. Trainor (2016). Measuring Neural Entrainment to Beat and Meter in Infants: Effects of Music Background, *Frontiers in Neuroscience*. 10(MAY).
[313] Alan Armstrong, and Johann Issartel (2014). Sensorimotor Synchronization with Audio-visual Stimuli: Limited Multisensory Integration, *Experimental Brain Research*. 232(11), pp.3453 – 3463; and Lincoln J. Colling, Hannah L. Noble, and Usha Goswami (2017). Neural Entrainment and Sensorimotor Synchronization to the Beat in Children with Developmental Dyslexia: An EEG study, *Frontiers in Neuroscience*. 11(360), pp.1 – 14.

In context, the phenomenon of entrainment in the sociohistorical world once again exemplifies Nishida and Noë's world of action and organisation, as does it show how the 'material, biological, and historical [realms] are in fact standpoints for viewing the same world.'[314] Pedestrians crossing the swaying Millennium Bridge, understood as an ORDER system, were caught up in an ORDER system initiated and sustained within the material, biological, and sociohistorical world. This organised the walking patterns of pedestrians, which in turn organised the swaying bridge, and so on.

Unlike pendula, and maybe starlings, humans are situated within the material, biological, sociohistorical world, wherein our actions and intentions shape the world which, in turn, shapes our actions and intentions. We can act intuitively and intentionally. We intentionally create art, and, as we will see in Chapter 4, intentionally use art to shape and organise what we are. We are entangled in a complex web art, life, and entrainment, where what we intuitively and intentionally do shapes the world that, in turn, shapes that shapes what we intuitively and intentionally do.

However, the Millennium Bridge also shows how entrainment in the sociohistorical world is considerably more complex than in the material and biological world, and how humans are caught up in ORDER systems that resonate both with and within a sociohistorical context. It shows that ETMs and an ORDER system, while present, do not *fully* account for events on the Millennium Bridge. As will be shown in Chapter 4, while entrainment helps us understand events such as those on the Millennium Bridge to some extent, the gait of humans is far more than a material or biological process; in the sociohistorical world, how humans walk—their walking *style*—is also the work of art.

[314] Krummel (2012). *Basho, World, and Dialectics*. p.31.

Section 4: Conclusion

In conclusion, entrainment reveals the reciprocity between humans and the material, biological, and sociohistorical world in which they are situated, exemplifying Nishida and Noë's world of action and organisation. Upward entrainment occurs when individual actions shape organised activities, while downward entrainment occurs when organised activities shape individual behaviour. In other words, we both shape and get shaped by the world. Thus, entrainment provides a framework for understanding how humans both organise and are organised by their environment.

Within an ORDER system, activities are organised in such a way that, as Noë previously explained, 'the demands of the activity as a whole control, that is, they downward entrain, the behavior of the individuals caught up in it.'[315] In this context, '[w]holes are more than the sum of their parts'[316] and '[p]arts behave differently in wholes.'[317] Simply put, the behaviour of parts organise the whole which, in turn, organises the behaviour of the parts. In this way, the phenomenon of entrainment is a mechanism by which actions organise the world which, in turn, organises actions.

Chapter 3 will explore this further, looking on scientific studies interested in neuroecological entrainment. It will show how the world of action and organisation includes ORDER systems that involve interactions between our brains, sensorineural systems, sensorimotor systems, and an environment that includes other people. The chapter will end by identifying the limitations of these scientific studies, particularly interpersonal studies that mistake intentional synchronisation for spontaneous entrainment.

[315] Noë (2015). *Strange Tools.* p.5
[316] Gillett (2016). *Reduction and Emergence*. p.201.
[317] Ibid. p.201.

Chapter 4 will expand the discussion by examining how Nishida and Noë might respond to the use of entrainment as an empirical example. It will highlight the entanglement of art, life, and entrainment, showing how this entanglement shapes what we are. By distinguishing between spontaneous entrainment, intentional synchronisation, and intentional spontaneous entrainment, it shall be argued that entrainment is a phenomenon that artists can intentionally use as a tool to shape organised activities that shape what we are: an aesthetic phenomenon.

Chapter 3: Neuroecological Entrainment

On the 16th of December 1997, 700 people, predominantly children, were rushed to Japanese hospitals experiencing seizures, vomiting, and a loss of consciousness. Subsequent investigations discovered that each person had been watching an episode of the extremely popular animated show *Poketto Monsutā* ポケットモンスター (Pocket Monsters), later abbreviated to *Pokémon*, when they started to feel unwell.[318] The episode in question, *Dennō Senshi Porygon*[319] でんのうせんしポリゴン (Computer Warrior Porygon), exposed viewers to red and blue lights rhythmically flashing at around 12 Hertz (Hz). It was later discovered that 5 to 10.4% of viewers reported a similar response, but they did not require hospitalisation.[320] It is important to note that, when '[c]ompared with photosensitive epilepsy population data, the number of individuals who had visually induced seizures in the *Pokemon* incident […] appears to be high.'[321] While mass psychogenic illness, commonly referred to as mass hysteria, may be a contributing factor here, so called "*Pokemon Shokku*" ポケモンショック (Pokemon Shock) was reported by viewers with no history of photosensitive epilepsy or other photosensitive conditions reported. The incident raised significant concerns about the potential health risks of rhythmic visual stimuli, as well as exemplifying how our neurobiology is profoundly affected by the perceived rhythms of the world around us.

To explore how our neurobiology is affected by the many rhythms of our environment, the following chapter is organised into three sections. Section one investigates

[318] Takahashi Takeo, and Tsukahara Yasuo (1998). Pocket Monster Incident and Low Luminance Visual Stimuli: Special Reference to Deep Red Flicker Stimulation, *Pediatrics International*. 40(6), pp.631 – 637.
[319] Kiyotaka Isako (Director), and Junki Takegami (Writer) (1997). Dennō Senshi Porygon, *Pokémon*. Season 1, Episode 38. Original air date: December 16, 1997.
[320] Takeo, and Yasuo (1998). *Pocket Monster Incident*. pp.631 – 637.
[321] Ibid. p.635.

neural entrainment. It describes the anatomy and electrical behaviour of neurons, arguing that entrainment requires 'cross-frequency coupling'[322] between neural oscillations.

Section two investigates sensorineural entrainment. It describes how our neurobiology, specifically the sensory nervous system (SNS), transforms conducted, radiated, convected, and advected energy from the environment into neural oscillations. This will be supported by experiments in neuroscience and behavioural psychology looking at vocal entrainment in infants, as well as circadian rhythms, and jet-lag.

Section three investigates sensorimotor entrainment. Building upon the previous two sections, and thematically borrowing from Bruno H. Repp and Yi-Huang Su,[323] this section describes 1. Tapping studies, 2. Movement studies, and 3. Interpersonal studies, arguing that the increasing complexity of all three exemplify the novel concept of neuroecological entrainment, as well as the limits of contemporary science when investigating this phenomenon.

The thesis of this chapter is that neuroecological entrainment provides a concrete and empirical explanation for the world of action and organisation, and for how actions and intuitions organise the world which, in turn, organises actions and intuitions. It demonstrates how, just like pendula, starlings, and bridges, our neurobiology is an open energy system, having the ability to transfer and absorb energy with a world that transfers and absorbs energy with us. This is Nishida and Noë's world of action and organisation from Chapter 1, wherein our neural, sensorineural, and sensorimotor systems are caught up in ORDER systems that shape and organise what we can and will do. Neuroecological entrainment, as we will see, situates action and cognition within the material, biological, and sociohistorical world discussed in Chapter 2, thus setting the stage for Chapter 4. In that chapter, it will be

[322] Canolty, and Knight (2010). *The Functional Role of Cross-frequency Coupling*. p.508.
[323] Repp, and Su (2013). *Sensorimotor synchronization*.

shown how spontaneous entrainment is as a tool that artists can intentionally use to shape the organised activities that ultimately shape what we are.

Section 1: Neural Entrainment

The human brain is an open energy system, meaning that the ETMs of conduction, radiation, convection, and advection are all applicable, as is the phenomenon of entrainment and the ORDER system it entails. However, the ETMs involved here need further refinement. So far, we have been looking at thermal and fluid dynamics, where energy and matter are transferred by conduction, radiation, convection, or advection. To understand the ETMs involved with and within the brain, we must first look at its most basic component: the neuron.

1.1 The Anatomy and Electrical Behaviour of a Neuron

A single neuron (N1) is a cell. It typically has a body or soma, a dendrite tree, an axon, and an axon terminal.[324] The soma of N1 is composed of a nucleus enclosed in a membrane. This is where N1 processes and integrates the electrical signals it receives and transmits as internal voltage. At its membrane, small ions are pumped in opposite directions, with negatively charged sodium ions being pumped out and positively charged potassium ions being pumped in via a number of different molecular-scale ion gates.[325]

N1's dendrite tree branches out from the soma. This is where N1 receives electrical signals which then get processed and integrated within the soma. N1's axon is a long narrow protrusion that extends its soma. In the human brain and central nervous system CNS (hereafter referred to as brain), the axon typically has a myelin sheath composed of water,

[324] Michael O'Shea (2005). *The Brain: A Very Short Introduction*. New York, United States: Oxford University Press Inc. Chapter 3, pp.28 – 41.
[325] O'Shea (2005). *The Brain*. p.32.

simple proteins, and fats.[326] In a process referred to as 'saltatory conduction,'[327] the myelin sheath acts as an insulator that increases the speed of conduction from the soma along the axon, finally reaching N1's axon terminal where electrical signals are then transmitted.[328] Thus, at its most basic level, N1 is a cell that receives, processes, integrates, and transmits electrical signals.

N1 has two states: a resting state (N1r), where no electrical signal is being transmitted, and an active state (N1a), where an electrical signal is being transmitted. While the internal mechanisms and processes here are complex, N1a exhibits *action potential*, as Stan Franklin explains:

> [The] dendritic tree collects excitatory and inhibitory inputs from other neurons, and passes these messages, as voltages, on to the cell body or soma. These voltages are added to its current voltage, if excitatory, or subtracted, if inhibitory. When a threshold is exceeded, an output voltage signal is transmitted down an axon to synapses that connect the leaves of the axonic tree to the dendrites of other neurons.[329]

In other words, when N1's internal voltage reaches a sufficient threshold, typically +50 millivolts (mV) or higher,[330] it fires, thereby transmitting an electrical signal from the soma along the axon to the axon terminal and getting discharged.

Additionally, ions crossing N1's membrane can also contribute to its internal voltage, as '[a] very small excitation will open a few [ion] gates, allowing the inflow of sodium […], thus opening more sodium gates. If enough sodium gates are opened we quickly enter a

[326] O'Shea (2005). *The Brain*. p.37.
[327] Brian C. Lim, and Matthew N. Rasband (2020). Saltatory Conduction: Jumping to New Conclusions, *Current Biology*. 30(7), pp. R326 – R328; and Charles C. H. Cohen, Marko A. Popovic, Jan Klooster, Marie-Theres Weil, Wiebke Möbius, Klaus-Armin Nave, and Maarten H. P. Kole (2020). Saltatory Conduction Along Myelinated Axons Involves a Periaxonal Nanocircuit, *Cell*. 180(2), pp.311 – 322.e15.
[328] O'Shea (2005). *The Brain*. p.37.
[329] Stan Franklin (1995). *Artificial Minds*. London, England: The MIT Press. p.123.
[330] O'Shea (2005). *The Brain*. p.32

positive feedback loop.'[331] This further contributes to N1's internal voltage and potential firing, albeit to a far lesser extent relative to the electrical signals it receives. N1 can thus be understood as what Franklin calls 'a linear threshold device,'[332] being capable of receiving and potentially transmitting electrical signals once a sufficient threshold is met.

1.1.1 The Coupling of Two Neurons

Let us add a second neuron (N2), taking all of the above a multiplying it by two. Like N1, N2 is also 'a linear threshold device.'[333] It typically has a soma, dendrite tree, axon, and axon terminal, being capable of receiving and, when a sufficient threshold is met, transmitting electrical signals. N2 also has a resting state (N2r) and an active state (N2a). It is their shared anatomy that allow N1 and N2 to create a coupled system, as electrical signals can be transferred where the axon terminal of one is connected to the dendrite tree of the other.

Where N1 and N2 connect a synapse is formed.[334] Given that a single neuron typically has around 30,000 synapses,[335] for the sake of simplicity, we shall focus on one for the moment. A single synapse can be electrical or chemical. In both cases, it is the formed synapse that enables N1a to transfer electrical signals to N2r, and vice versa.

While electrical and chemical synapses both provide the same function of transferring electrical signals between neurons, they do so with different transfer mechanisms. Direct contact forms an electrical synapse. This is when the axon terminal of one neuron directly connects to a dendrite tree of another. In such a coupling, N1a directly transfers an electrical signal to N2r, which is then integrated and processed at its soma and, if

[331] O'Shea (2005). *The Brain*. p.35.
[332] Franklin (1995). *Artificial Minds*. pp.124 – 128.
[333] Ibid. pp.124 – 128.
[334] O'Shea (2005). *The Brain*. pp.38 – 40.
[335] Mimi Shin, Ying Wang, Jason R. Borgus, and B. Jill Venton (2019). Electrochemistry at the Synapse, *Annual Review of Analytical Chemistry*. 12(1), p.298.

the required threshold is exceeded, causes N2a. As is the case if an electrical synapse connects N2a and N1r.

Direct contact between two neurons means that, as O'Shea explains, 'electrical signals pass with almost no delay from one neuron to another [with] electricity being able to pass equally well in both directions.'[336] Adam C. Miller and Alberto E. Pereda expand further, explaining that 'electrical synapses are bidirectional, and therefore, when depolarization propagates to a coupled cell […] the depolarization evoked in this cell (coupling potential) simultaneously propagates back to the cell on which the depolarization initially originated.'[337] Put another way, the anatomy of two neurons coupled by a single electrical synapse allows for the mutual and bidirectional transfer of electrical signals between the two. This then allows for rapid and alternating signalling between neurons. In short, an electrical synapse enables electrical signals to travel in both directions.

For example, when N1a fires, its electrical signal is transmitted to N2r through an electrical synapse. If, as a consequence, N2r exceeds the required threshold and fires, then N2a's electrical signal can be transmitted back to N1 through the exactly the same synapse. As they exchange electrical signals, this can, in principle, create a feedback loop where N1 and N2 alternate between their active and resting states in response to each other.

This alternating frequency is known to strengthen the connections between neurons, as well as potentially lowering their required thresholds for firing, making their signalling become increasingly synchronised.[338] Hebbian Learning, as articulated by Donald Hebb in *The Organization of Behavior: A Neuropsychological Theory*, posits that '[w]hen an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it,

[336] O'Shea (2005). *The Brain*. p.38.
[337] Adam C. Miller, and Alberto E. Pereda (2017). The Electrical Synapse: Molecular Complexities at the Gap and Beyond, *Developmental Neurobiology*. 77(5), p.562.
[338] O'Shea (2005). *The Brain*. p.35.

some growth process or metabolic change takes place in one or both cells such that A's efficiency, as one of the cells firing B, is increased.'[339] Colloquially summarised as "neurons that fire together wire together," Hebbian learning strengthens the connections between N1 and N2, thereby lowering their respective thresholds for firing, and is thus a mechanism for learning by association. Accordingly, an electrical synapse is a bidirectional transfer mechanism, enabling mutual and increasingly synchronised signalling between N1 and N2, which, as we will see, can potentially facilitate entrainment.

In contrast, a chemical synapse, which is more common than an electrical synapse, is formed when neurons transmit and revive small chemicals known as neurotransmitters.[340] N1a, for example, sends an electrical signal along its axon the axon terminal, which causes it to release neurotransmitters. These neurotransmitters then enter the small gap between N1 and N2, the so-called synaptic cleft, getting picked by the dendrite tree of N2r. N2r's dendrite tree then converts theses chemical signals back into an electrical signal, subsequently integrating and processing them at its soma. If N2r then exceeds the required threshold, it becomes active and fires. However, N2a cannot send an electrical signal back to N1 through the very same chemical synapse. For N2a to send a signal back to N1, its axon terminal must be connected to N1's dendrite tree by way of a second synapse. This added complexity means that an electrical signal transmitted by a chemical synapse is non-mutual and unidirectional. In short, a chemical synapse enables electrical signals to travel only one way, from an axon terminal to a dendrite tree.

Of course, if N1 and N2 were connected by a second synapse, be it chemical or electrical, then the mutual exchange electrical signals could also create a feedback loop where both neurons alternate between their active and resting states in response to each other. So too

[339] Donald Hebb (1949). *The Organization of Behavior: A Neuropsychological Theory*. New York; John Wiley & Sons, Inc. p.62. Emphasis removed.
[340] Franklin (1995). *Artificial Minds*. p.123.

strengthening their connections, lowering their required thresholds for firing, and making their signalling become increasingly synchronised. Thus, the transfer mechanism of a chemical synapse is unidirectional and non-mutual, in contrast to the bidirectional and mutual transfer mechanism of an electrical synapse.

1.1.2 The Unlikely Entrainment of Two Neurons

In the previous chapter, entrainment was defined as an ORDER system. It is an open, resonating, dissipating, emergent, and rhythmic system, spontaneously initiated and sustained by the transfer of energy. Given its prevalence in the material, biological, and sociohistorical world, it makes sense that an ORDER system can also be found in the human brain.

As of yet, entrainment has not been identified between just two neurons. Part of the problem is that the anatomy and electrical behaviour of a single neuron is as small as it is complex, making it difficult to fully investigate the ETM's at play between just two. However, the given model illustrates the underlying mechanisms at play when neuroscientists identify and measure entrainment between large brain regions. With that in mind, let us explore whether N1 and N2 can, in principle, meet the requirements of an ORDER system.

The first feature of an ORDER system is that it must be open, requiring the transfer of energy between two or more systems and their surroundings. N1 and N2 meet this requirement. For instance, if the axon terminal of N1a is connected to the dendrite tree of N2r by an electrical synapse, this coupling enables a bidirectional and mutual transfer of electrical signals. However, this is not the case if the axon terminal of N1a is connected to the dendrite tree of N2r by a chemical synapse. Chemical synapses, as we saw, only go one way, enabling the unidirectional transfer of electrical signals. Nonetheless, if the axon terminal of N1 is connected to the dendrite tree of N2 by a chemical synapse, and likewise with the axon terminal of N2 and dendrite tree of N1, then this coupling could enable a bidirectional and

mutual transfer of electrical signals between the two. There are no prohibitions on two neurons coupling in this way. A chemical synapse just adds a level of complexity not found with an electrical. Therefore, N1 and N2 are an open system that can transfer electrical signals to each other, with the complexity of this coupling being dependent on the type and number of synapses between.

N1 and N2 are also open to their surroundings. Both neurons receive and transmit electrical signals from each other, with other neurons (much more on this later), as well as with the brain more generally. Situated within the human brain, N1 and N2 are surrounded by fats, proteins, salty water, and glial cells which do not conduct electrical impulses. At N1 and N2's membrane, ion gates enable positively and negatively charged ions to be both transferred and received, being 'achieved by the ability of molecular-scale pumps to couple the expenditure of metabolic energy to the movement of ions.'[341] The human brain is responsible for 20% of the body's overall energy expenditure, with the body's sensorineural and sensorimotor systems also absorbing and transferring energy from the surrounding world. As such, N1 and N2 are part of a much larger open energy system that includes the brain, the body, and, ultimately, the world. Therefore, N1 and N2 meet the first requirement for an ORDER system, as they transfer energy to each other and their surroundings.

The second feature of an ORDER system is that it must be resonating. N1 and N2 both have a similar natural frequency, to the extent that they are both linear threshold devices that can alternate between their active and resting states. Resonance between N1 and N2 can, in principle, occur when a forced frequency increases the amplitude of each neuron's natural frequency. Coupled by just one electrical synapse, N1 and N2 can transmit and receive signals in both directions. Likewise, when coupled by at least two chemical synapses. The electrical signals transferred back and forth between N1 and N2 can then initiate a positive

[341] O'Shea (2005). *The Brain*. p.32.

feedback loop where each system resonates with other, causing them to alternate between their active and resting states. N1a fires and initiates N2a, then N1r. N2a fires and initiates N1a, then N2r. And so on. As N1 and N2 alternate between their active and resting states, this process is sustained for as long as the electrical signal transferred each time is sufficient to meet the required threshold of a single neuron.

Note that, as we will see in later sections, it is unlikely that just one neuron can transmit an electrical signal strong enough to exceed the required threshold of another. This is partially because, as we saw, neurons are an open system. Exceeding the required threshold of just one neuron typically requires hundreds, if not thousands of electrical signals being transmitted, integrated, and processed. This is because the voltages at play between just two neurons is relatively small and, more importantly, '[a]xons are very poor conductors of electricity, so bad in fact that over relatively short distances […] most of the original signal will leak away.'[342] Nonetheless, if the signals were sufficient, then the mutual transfer of electrical signals between N1 and N2 could initiate and sustain a resonating system.

The third feature of an ORDER system is that it must be dissipating, with the overall energy of the system becoming increasingly disordered as entropy increases. Simply put, the coupling of N1 and N2 must inevitably end. N1 and N2 meet this requirement. Like we saw in the first feature, like all other energy systems, N1 and N2 are an open energy system and, as such, subject to the laws of thermodynamics and entropy. If not, N1 and N2 could alternate between their active and resting states indefinitely, making them immortal. If N1 and N2 were a perfectly closed energy system, the electrical signal passed back and forth between would continue infinitely, provided that it was initially sufficient to meet the required threshold of a single neuron. Any signals transferred between N1 and N2 must inevitably dissipate and end, as must their coupling. This is a basic fact about the universe, as is it about

[342] O'Shea (2005). *The Brain*. p.30.

N1 and N2. Therefore, it is trivially true that N1 and N2 meet the third requirement for an ORDER system, as they are a dissipating energy system.

N1 and N2 are also subject to a myriad of external forces and ETMs, many of which can contribute to the dissipation of energy. At N1 and N2's membrane, ion gates enable ions to be both transferred and received with their surroundings. N1 and N2 are also part of a wider energy system that both transfers and absorbs energy between the brain, body, and world, all of which contribute to the dissipation of energy between N1 and N2.

While it is trivially true that N1 and N2, like everything else in the universe, are a dissipating system, this specific system offers a moment of what Schrödinger called negentropy in Chapter 2, Section 1.1.1. This is far from trivial. In fact, it is the very basis for life. Negentropy provides order in a disordered universe, as does it provide brief moments of order between neurons in the brain.

It is important to note that N1 and N2 also transmit and absorb energy by way of conduction, radiation, convection, and advection. For example, in the human eye, photoreceptors transform radiated energy into electrical signals by way of a process called *sensory transduction*. To be explored in detail in Section 2 of this chapter, this remarkable process 'involves converting the energy in the sensory stimulus, in this case light energy, into an electrical signal.'[343] In other words, our sensorineural system absorbs energy from our environment, thereby converting it into electrical signals. However, given the asymmetry between a single neuron, as well as the relatively small electrical signals and voltages at play, these ETM are largely one way, from the environment to the neuron.

Putting aside the fact, for the moment, that when we act in and with the world our sensorimotor systems also convert electrical signals back into more effective forms of energy,

[343] O'Shea (2005). *The Brain*. p.7.

resulting in, for example, muscular contradiction, it yet remans that the energy and electrical signals transferred by just one cell is insignificant in comparison to the energy transferred by conduction, radiation, convection and advection. N1 and N2 are affected by the many ETMs in the world around us, yet they do not have the ability to couple with them in any significant or noticeable way. Thus, conduction, radiation, convection, and advection, while ever present, are insufficient to create a coupled system between the N1, N2, and their environment.

The fourth feature of an ORDER system is that it must be emergent, evoking a brief moment of organisation in an increasingly entropic and disordered universe. In the previous scenario between N1a and N2r, there is the potential for a period of emergent synchronisation. N1a, being at the higher voltage can "pull up" the voltage of N2r by the signals it transmits. Conversely, N2r, being at the lower voltage can "pull down" the voltage of N1a by the signals it receives. As N1a fires, it transmits a signal to N2r. This signal then gets processed and integrated by N2r, thus increasing its internal voltage. If the received signal is sufficient, then N2r becomes active and fires. As N2a fires, it transmits a signal back to N1r, which in turn increases its internal voltage. If the received signal is sufficient, then N1r again becomes active and fires, and so forth.

Evidence of this is when the bidirectional transfer mechanism of an electrical synapse enables a rapid and increasingly synchronised signalling between neurons.[344] Additionally, when N1 and N2 continue to exchange electrical signals, this enables an increasingly synchronised signalling as both alternate between their active and resting states. This is an alternating feedback loop where their respective voltages and signalling becomes increasingly synchronised.[345] Therefore, N1 and N2 can meet the fourth requirement for an ORDER system, as the energy transferred between enables an emergent period of synchronisation.

[344] Miller, and Pereda (2017). The Electrical Synapse. p.562.
[345] O'Shea (2005). *The Brain*. p.35.

The final feature for an ORDER system is that it must be rhythmic, involving the transfer of energy in a recurring, periodic, and oscillating pattern between two or more energy systems. Importantly, these *systems must be independently oscillating at a frequency prior to their coupling*. N1 and N2 fail to meet this requirement. This is because N1 and N2 only alternate between their active and resting states. They do not oscillate independently, only in response to each other (See *Figure 1*).

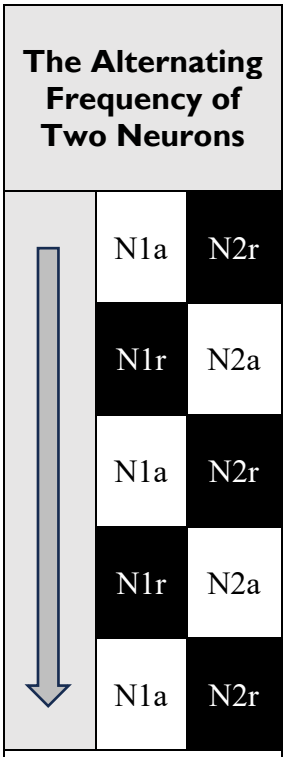

Figure 1

In the previous chapter, Bittman made a distinction between entrainment and synchronisation. Using the example of ducking when someone shoots, Bittman wrote: 'neither the act of shooting nor the act of ducking is controlled by an oscillator, [yet] they occur at the same time, that is, they are synchronized.'[346] Likewise, when N1a fires, then N2a, then N1a, N2a, and so on, this alternating frequency is not controlled by an oscillator yet synchronised. This is because neurons only become active when the required threshold is exceeded. N1a only occurs in response to N2a. N2a only occurs in response to N1a. N1 and N2 do not oscillate independently and, as such, do not rhythmically transfer energy to each other. It is only together that they alternate at a shared frequency: N1a, N1r, N2a, N2r, N1a, N1r, and so on.

To understand the difference between an alternating and an oscillating frequency, let us return to the example of Huygens' oscillating pendulum. Independently, P1 oscillates at its own frequency, swinging back-and-forth. P1 swings to the left until it reaches the highest point of the pendulum's arc, then swings to right until it reaches the highest point, then to the left, to the right, and so on. This is its natural frequency. Note that the movement of P1 is an

[346] Bittman (2021). *Entrainment is NOT Synchronization*. pp.196 – 199.

independent process. It is not merely repetitive and reoccurring, but rather a continuous movement or process.

N1 and N2, in contrast, are repetitive and reoccurring, but not a continuous movement or process. Both alternate between their active and resting states only after transmitting or receiving an electrical signal. While the emergent pattern between N1 and N2 is rhythmic and synchronised, it is an alternating frequency rather than a recursive and oscillating one. Therefore, N1 and N2 fail to meet the final requirement for an ORDER system, as they do not individually oscillate, only alternating between active and resting states when coupled.

1.1.3 The Potential Entrainment of Four Neurons

Now adding a third (N3) and fourth (N4) neuron, once again taking all of the above and multiplying it by two, for a total of four neurons. Just like N1 and N2, N3 and N4 both have a soma, dendrite tree, axon, and axon terminal, as well as the ability to couple with each other via shared synapses. Both are also electrically excitable cells and linear threshold devices. They have a resting state (N3r, N4r) and an active state (N3a, N4a). Importantly, they too fail to meet the final requirement for an ORDER system, as together N3 and N4 alternate at the shared frequency of N3a, N3r, N4a, N4r, N3a, N3r, and so on. As such, N3a is conditional on N3r and N4a, and N4a is conditional on N4r and N3a. Thus, on their own, N3 and N4 do not involve a recursive, reoccurring, and rhythmic transfer of energy between each other, given that they do not oscillate at an independent frequency prior to their coupling.

However, while N3 and N4 do not rhythmically transfer electrical signals to each, merely alternating between active and resting states, they can do so when coupled with N1 and N2. This is because an alternating frequency between N1 and N2 is an oscillating frequency that can coupled with the alternating frequency of N3 and N4.

Once again, it will be helpful to think of this in the context of Huygens' two pendula. As the oscillating frequency of P1 alternates between the extreme left and right, so too does the frequency of P2. Similarly, as N1 and N2 alternate between their active and resting states, this creates an oscillating frequency which continuously transmits and receives electrical signals when coupled with N3 and N4, and vice versa. Similar to how P1 and P2 transfers energy to the wall and each other by way of the ETM of conduction, thereby subtly altering each other's frequency, N1 and N2 coupled to N3 and N4 transfer electrical signals to each other by way of electrical or chemical synapses.

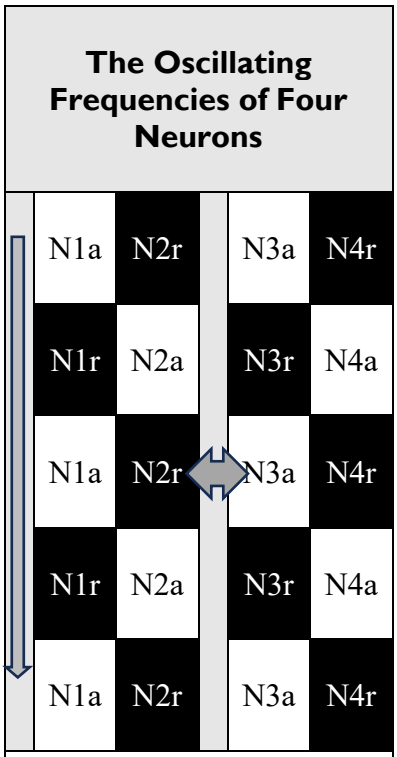

Figure 2

As shown in *Figure 2*, the electrical signals transmitted from N1 and N2 make N3 and N4 alternate at a slightly different frequency. As N3 and N4 alternates at a slightly different frequency, they too transmit electrical signals to N1 and N2, making them alternate at a slightly different frequency. As with P1 and P2, as this process continues, the oscillating frequencies of N1 and N2 coupled with N3 and N4 become increasingly synchronised until a shared oscillating frequency emerges. Therefore, at least four neurons are required to initiate an ORDER system.

1.2 The Collective Electrical Behaviour of Neurons

Admittedly, the previous explanatory model is a simplistic one. It fails to account for a human brain that is estimated to have over one hundred billion neurons, with each individual neuron having a minimum of 1000 synapses.[347] That is over one hundred trillion potential connections. Every second, N1, N2, N3, and N4 transmit and receive electrical

[347] O'Shea (2005). *The Brain*. pp.22 – 29.

signals with hundreds, if not thousands, of other neurons. Exceeding the required threshold of a single neuron typically requires hundreds of electrical signals being transmitted, integrated, and processed. Consequently, meeting the required threshold of a single neuron typically involves vast and complex interconnected circuits of neurons interacting across different regions if the brain. Thus, the probability of a single neuron exceeding its threshold and firing increases relative to the number of synapses and connected neurons.

1.2.1 A Useful Metaphor

Neurons do cause each other to fire. Accordingly, we must exponentially increase the size and complexity of our explanatory model. Given the number of neurons and potential connections, this is a considerable task, requiring a model that includes billions of neurons connected in trillions of different potential permutations. To help get a grasp on such numbers, let us borrow from the parable of the mathematician and the king, highlighting what is often referred to as 'The wheat and chessboard problem.'[348] A common variation of this story is as follows:

> the court mathematician in India […] invented the game of chess for his king. The king was so pleased with the game that he offered to repay the mathematician, whose request seemed modest enough. The mathematician requested a single grain of wheat on the first square of the chessboard, two grains on the second square, four on the third square, and so on.[349]

The problem with this request, the king soon realised, was that upon reaching the final square, the whole chess board would have more grains of wheat on it than had ever existed in the history of the planet; 18,446,744,073,709,551,615 grains of wheat. That is over 1.4

[348] Alberto Bardi (2021). Mathematics and Cultures Across the Chessboard: The Wheat and Chessboard Problem, In – Bharath Sriraman, Ed. (2021*). Handbook of the Mathematics of the Arts and Sciences* (1st ed.). Springer International Publishing AG. pp. 2421 – 2443

[349] Paul G. Hewitt (2020). Exponential Growth and Doubling Time, *The Science Teacher (National Science Teachers Association)*. 87(9), p.17.

trillion metric tons. This story highlights the power of exponential growth, specifically when increasing by a factor of two each time.

Let us now apply the same exponential growth to our model, continuing to increase the number of neurons by a factor of two each time. To start, let us "place" N1 on the first square (a1) of a metaphorical chessboard. In this position, N1 is an electrically excitable cell, having the ability to couple with any neurons "placed" on the three adjacent squares (a2, b1, and b2). Moving to the right, on the second square (b1) let us then add N2 and N3. Like N1, both neurons are electrically excitable cells, having the ability to couple with each other, as well as any neurons added to the five adjacent squares (a1, a2, b2, c1 and c2). Note that the two neurons on a2 are twice as likely to cause N1a than the single neuron on a1 is to cause N3a and N4a. Yet, even with a combined total of three, it remains unlikely that the electrical signals transmitted and received here would be sufficient to meet the required threshold of any single neuron.

Having added N1 to the first square, N3 and N4 to the second, let us keep moving to the right, adding four neurons to the third square (c1), then eight on the fourth square (d1), sixteen on the fifth (e1), thirty-two on the sixth (f1), and so on. Continuing to add neurons to each square, increasing by a factor of two each time, we eventually fill in the three squares adjacent to N1 (a2, b1, and b2). With a combined total of 771 neurons, the probability of any single neuron exceeding its threshold and firing increases by several orders of magnitude. If, in an unlikely scenario, N1r received electrical signals from the surrounding 770 neurons, then the chances of it becoming active and firing increase exponentially. Yet, even between 771 neurons, the voltages at play here are relatively small, made worse by the fact that, once again, '[a]xons are very poor conductors of electricity.'[350] Consequently, even in a best case

[350] O'Shea (2005). *The Brain*. p.30.

scenario, where 770 active neurons all send electrical signals to N1r, this still might not be sufficient to exceed its required threshold.

As we continue to add neurons to each square, increasing by a factor of two each time, we soon reach the estimated one hundred billion neurons of the human brain. At square 10 (b2) we have a total of 512 neurons on our metaphorical chessboard; at square 20 (d3) over five hundred thousand; at square 30 (f4) over five hundred million. At square 38 (f5), we have far exceeded the required one hundred billion. Given that the probability of a single neuron firing increases relative to the surrounding neurons (and squares), the chance of exceeding the required threshold increases exponentially and by order of magnitude as we move up the chessboard.

In this model, each square, with the exception of a1, represents a circuit of neurons. These circuits can have vastly different densities, often dependent on where they are located in the brain and on our metaphorical chessboard. These circuits can then generate an oscillating frequency, altering the frequency of the individual neurons within, as well as the frequency of those adjacent circuits. In such a system, the electrical behaviour of individual neurons shapes the collective electrical behaviour of small circuits which, in turn, shapes the electrical behaviour of individual neurons.

The chessboard itself can thus be understood as a metaphor for the human brain. Each grain of wheat is a single neuron, each square a small circuit. When we consider specific regions of the chessboard, we find “piles” of wheat at varied densities. Similarly, when we consider the different regions of the brain, we find neurons forming circuits of varied densities. Just as the amount of wheat differs dramatically depending on what region of the board we look at, the density of neurons and their potential connections can differ depending on what region of the brain.

Evidently, we are reaching the limits of this metaphor. The linear exponential growth given does not accurately convey how the brain is actually structured. There is no linear growth of neurons in the brain, with one region having two, the next four, then eight, sixteen, thirty-two, sixty-four, and so on. A better approximation would be if we randomised or reorganised the squares on the chessboard, the number of neurons on each, while also allowing the squares and wheat to continuously move around the board. This would allow for different regions of the brain to have different neuron densities and, thus, circuits.

Nevertheless, this metaphor illustrates the vast range of potential interactions and connections between neurons, and how their collective electrical behaviour can include circuits composed of thousands of neurons, and how circuits of different neuron densities overlap in different regions of the brain. Like the king in the story, neuroscientists trying to understand the collective electrical behaviour of neurons today are faced with a complexity so vast that it goes far beyond our current capabilities. Nevertheless, by applying the idea of exponential growth, and considering each square as a small circuit that can transmit and receive electrical signals from those adjacent, and vice versa, we can begin to appreciate dynamic propagation of electrical signals within the human brain.

1.2.2 Neural Oscillations

First measured by German psychiatrist Hans Berger[351] (1873 – 1941), notable inventor of electroencephalography and the electroencephalogram (both abbreviated to EEG), neural oscillations, what are commonly known as brainwaves, are the rhythmic and propagating firing patterns of neurons. Berger first noticed these when he placed small metal electrodes on the scalp of patients, with the goal of measuring the collective electrical activity

[351] L. F. Haas (2003). Hans Berger (1873–1941), Richard Caton (1842–1926), and Electroencephalography, *Journal of Neurology, Neurosurgery and Psychiatry*. 74(1), p.9.

of neurons.[352] Berger discovered 'that brain activity changes in a consistent and recognizable way when the general status of the subject changes, as from relaxation to alertness.'[353] He also discovered that the electrical activity of the brain can exhibit an oscillating frequency, in the sense that, every second, waves of firing neurons oscillate and ripple throughout the brain. Like a murmuration, patterns emerge and dissipate in the brain. There is a visible ebb and flow to a neural oscillation, with neurons firing together with an almost liquid-like fluidity. Hence the name brain waves. A neural oscillation is partially that of coordination, order, and synchronisation, where millions of individual neurons show an ability to fire in an extremely complex and organised formations.

Since Berger, neural oscillations have been identified in electrocorticography (ECoG), magnetoencephalography (MEG), as well as more refined versions of the EEG that will be the main focus of the following sections. Daniel H. Mathalon and Vikaas S. Sohal explain that 'neural oscillations are rhythmic fluctuations over time in the activity or excitability of single neurons, local neuronal populations or assemblies, and/or multiple neuronal assemblies distributed across brain regions.'[354] In other words, neural oscillations involve the rhythmic oscillations of individual neurons, like N1, of small circuits like between N1 and N2, as well as between multiple circuits in different regions of the brain, CNS, and PNS, as in between N1 and N2 when coupled with N3 and N4, and so on. Neural oscillations detectable by EEG typically involve substantially larger populations of neurons, often numbering in the millions.

Building on Berger's initial discovery, neural oscillations are today recognised to fall into two broad categories: Resting or baseline and event-related. A resting neural oscillation is '[w]hen spontaneous neural oscillations are recorded over time without intervening

[352] Priyanka A. Abhang, Bharti W. Gawali, and Suresh C Mehrotra (2016). *Introduction to EEG – and Speech-based Emotion Recognition (1st ed.).* Elsevier Science & Technology. p.20.
[353] Abhang et al. (2016). *Introduction to EEG*. p.20.
[354] Daniel H. Mathalon, and Vikaas S. Sohal (2015). Neural Oscillations and Synchrony in Brain Dysfunction and Neuropsychiatric Disorders: It's About Time, *JAMA Psychiatry*. 72(8), p.840.

stimulus events.'[355] These typically oscillate at a frequency or waveform between 0.5 and 12 hertz (Hz), being associated with relaxation and more passive mental states. A Hz is the number of oscillations or cycles per second. As such, resting neural oscillations can range from four per second to twelve.

Resting neural oscillations are often further categorised into three frequencies or brain waves. Delta Waves typically oscillate at a frequency between 0.5 and 4 Hz.[356] Given their relatively low frequency, Delta Waves are often measured in deep sleep, and even when dreaming. Theta Waves typically oscillate at a frequency between 4 and 8 Hz, often measured in light sleep, drowsy or deeply relaxed states.[357] Alpha Waves typically oscillate a frequency between 8 and 12 Hz. These are often measured in relaxed but alert states, such as passive attention, introspection, and reflection, as well as some meditative states.[358] Note that Delta, Theta, and Alpha Wave are not mutually exclusive, as there is often considerable overlap between.

Event-related neural oscillations, in comparison, have a much higher frequency. These 'neural oscillations are recorded during tasks in which stimuli are presented over many trials.'[359] These typically oscillate at a frequency or waveform starting at 12 Hz and often exceeding 100 Hz. Like resting neural oscillations, event-related neural oscillations are often categorised into two non-mutually exclusive frequencies or brain waves. Beta Waves typically oscillate at a frequency between 12 and 35 Hz, being associated with busy or active minds, as well as elevated levels of wakefulness and focused attention.[360] Gamma Waves typically oscillate at a frequency starting at 35 Hz, and far exceeding 100 Hz. These are often

[355] Mathalon, and Sohal (2015). *Neural Oscillations and Synchrony in Brain*. p.841.
[356] Abhang et al. (2016). *Introduction to EEG*. p.21.
[357] Ibid. p.21.
[358] Ibid. p.21.
[359] Mathalon, and Sohal (2015). *Neural Oscillations and Synchrony in Brain*. p.841.
[360] Abhang et al. (2016). *Introduction to EEG*. p.21.

associated with the extremely demanding cognitive activities, such as deep concentration, problem solving, and tasks that require mental and physical coordination.[361]

1.3 Neural Entrainment

Neural entrainment is a well recognised phenomenon in neuroscience. It has been linked to general cognitive development,[362] as well as social bonding,[363] vocalisation,[364] and even distress regulation.[365] Specifically, in studies looking at event-related neural oscillations in response to external stimulus events, such as perceived external rhythms.[366] Given that event-related neural entrainment is the main focus in the following two sections, as well as Chapter 4, let us first take a moment to look at resting or baseline neural entrainment. This is the entrainment between two or more neural oscillations with each other.

Neural entrainment can be identified in cases of cross-frequency coupling (CFC) where '[n]eural oscillations can be organized hierarchically such that the phase of slower oscillations modulates the amplitude, frequency, or phase of faster oscillations.'[367] Put another way, neural oscillations at a higher frequency can "pull up" the lower frequency, just as neural oscillations at a lower frequency can "pull down" the higher frequency.

A point that needs noting is that the literature on CFC often conflates entrainment with synchronisation. For example, in 'Neural Oscillations and Synchrony in Brain

[361] Abhang et al. (2016). *Introduction to EEG*. p.21.
[362] Colling, Noble, and Goswami (2017). *Neural Entrainment and Sensorimotor Synchronization*; and Simone Falk, and Christopher T. Kello (2017). Hierarchical Organization in the Temporal Structure of Infant-direct Speech and Song, *Cognition*. 163, pp.80 – 86.
[363] Daisy Fancourt, and Rosie Perkins (2018). The Effects of Mother–infant Singing on Emotional Closeness, Affect, Anxiety, and Stress Hormones, *Music & Science*. 1(0), pp.1 – 10; and Miriam D. Lense, Sarah Shultz, Corine Astésano, and Warren Jones (2022). Music of Infant-directed Singing Entrains Infants' Social Visual Behavior, *Proceedings of the National Academy of Sciences – PNAS*. 119(45), pp.1 – 9.
[364] Susanne Harder, Theis Lange, Gert Foget Hansen, Mette Væver, and Simo Køppe (2015). A Longitudinal Study of Coordination in Mother-infant Vocal Interaction From Age 4 to 10 Months, *Developmental Psychology*. 51(12), pp.1778 - 1790.
[365] Marième Corbeil, Sandra E. Trehub, and Isabelle Peretz (2016). Singing Delays the Onset of Infant Distress, *Infancy*. 21(3), pp.373 – 391.
[366] Nozaradan et al. (2016). *Individual Differences in Rhythmic Cortical Entrainment*. pp.1 – 12.
[367] Mathalon, and Sohal (2015). *Neural Oscillations and Synchrony in Brain*. p.842.

Dysfunction and Neuropsychiatric Disorders: It's About Time,'[368] wherein Mathalon and Sohal gave the previous quote, the word "entrainment" is never used once. This is not to say that Mathalon and Sohal are unaware of the phenomenon of entrainment. They actually cite a paper by Ryan T. Canolty and Robert T. Knight that explicitly recognises the link between entrainment and CFC, explaining how 'low-frequency activity can be entrained by rhythmic external sensory and motor events, as well as internal cognitive processes,'[369] and later adding that 'CFC implies that the modulation of high-frequency power by CFC will be entrained and coordinated with the occurrence of slower.'[370] Mathalon and Sohal are not the only ones to conflate synchronisation and entrainment. Yet, when looking at the CFC between neural oscillations, deeming the emergent frequency as merely synchronisation misses out on the underlying mechanisms at play, as well as the ORDER system of entrainment.

1.4 Summary and Context

In summary, neural entrainment can be understood as an ORDER system. Neurons, individually and collectively, are open systems, transferring energy to each other and their surroundings. Between neurons, electrical signals are received and transmitted via their axon terminal and dendrite tree. At a neuron's membrane, small ion gates also pump negatively charged sodium ions out and positively charged potassium ions in. Thus, neurons are an open energy system.

Neurons are also a resonating system. All neurons have a similar anatomy and electrical behaviour, and subsequent natural frequency. Individually, this natural frequency is displayed by the neurons action potential and inherent tendency to alternate between active and resting states. Collectively, neural oscillations also have a natural frequency. On the lower end of this natural variation, resting state neural oscillations have a frequency between

[368] Mathalon, and Sohal (2015). *Neural Oscillations and Synchrony in Brain*.
[369] Canolty, and Knight (2010). *The Functional Role of Cross-frequency Coupling*. p.508.
[370] Ibid. p.508.

0.5 and 12 Hz, being typically associated with relaxation and more passive mental states. At the higher end, event-related neural oscillations have a frequency that often exceeds 100Hz, being associated with demanding and active mental states. Resonance can occur by way of CFC. This is when a high frequency neural oscillation “pulls up” a relatively lower frequency, and when of low frequency neural oscillation “pulls down” a relatively higher frequency. Thus, neurons resonate with each other.

Neurons are also a dissipating system. All neurons must inevitably die, as must any coupling between them end. Less trivially, neurons are part of a wider energy system that includes the brain, body, and world. ETMs shared between all can contribute to the rapid dissipation of energy. Neural oscillations also transmit and absorb energy by way of conduction, radiation, convection, and advection, most notably in event-related neural oscillations, as will be the focus of Section 2 to follow. Nevertheless, like all other energy systems, neurons are open and, as such, subject to the laws of thermodynamics and entropy. If not, neural oscillations could continue indefinitely. Thus, neurons are a dissipating system, individually and collectively.

Neurons are also an emergent system, in the sense that CFC and resonance can initiate and sustain a period of emergent synchronisation. As a higher frequency “pulls up” a lower, and a lower frequency “pulls down” a higher, synchronisation emerges. This is sustained for as long as neurons remain coupled. This oscillating feedback loop enables a brief moment of synchronisation and organisation in the brain. Thus, neurons can form an emergent system.

Neurons are also a rhythmic system. The collective electrical behaviour of neurons displays a recurring, periodic, and oscillating pattern. A single neuron alternates between active and resting states. This not recuring or periodic, insofar as it requires at least one more neuron to do so. Two coupled neurons, in principle, can oscillate between their active and

resting states in a recurring and periodic pattern. However, due to anatomical constraints, this is only possible (albeit unlikely) when connected by an electrical synapse. Large circuits of neurons do display a recurring, periodic, and oscillating pattern. These systems independently oscillate at their own frequency prior to any CFC. This rhythm continues while coupled, altering the frequency of both. Thus, neurons are a rhythmic system, displaying a recurring, periodic, and oscillating pattern.

In context, this further exemplifies how, within the world of action and organisation, ORDER systems are considerably more complex in the biological realm than those found in the material. It demonstrates how, like animals, bacteria, fungi, and plants, our neurobiology is subject to the many ETMs around us, as well the ORDER system of entrainment. It also shows how, within the ORDER system of our brain, '[w]holes are more than the sum of their parts'[371] and '[p]arts behave differently in wholes.'[372] From the bottom up, individual neurons shape the electrical activity of the brain as a whole. From the top down, the electrical activity of the brain as a whole shapes the electrical activity of individual neurons. Upward and downward entrainment between neural oscillations is not a thought experiment, metaphor, or hypothetical; it is a well-recognised and documented phenomenon.

The phenomenon of neural entrainment can be understood as a manifestation of Nishida and Noë's world of action and organisation. Like a starling caught up in a murmuration, the electrical activity of a neuron both organises and gets organised by the electrical activity of the brain, thus showing how the brain entails action and organisation. Like *kōiteki chokkan*, where '[w]hat we do shapes what we are, shapes the world that in turn shapes us,'[373] the electrical behaviour of a neuron both shapes and gets shaped by the

[371] Gillett (2016). *Reduction and Emergence*. p.201.
[372] Ibid. p.201.
[373] Maraldo (2017). *Japanese Philosophy in the Making*. p.199. Emphasis removed.

electrical activity of the brain. Therefore, the phenomenon of entrainment provides a mechanism for understanding how the world of action and organisation applies to the brain.

However, our brains are just one part of the picture. We also act in and perceive the world around us. We have sensorineural and sensorimotor systems, both of which can potentially contribute to ORDER systems between us and our perceived environments. In Chapter 2, Section 3, the example of the Millennium Bridge was used to show that entrainment in the sociohistorical world is far more complex than it is in the material and biological. This is because, as Noë rightly asserts, we are an 'embodied, environmentally and socially situated human animal that thinks and feels and decides and is conscious.'[374] While the brain is necessary, it is far from sufficient. It also requires a material, biological, and sociohistorical world to interact with it.

The following two sections will expand on neural entrainment, providing examples of sensorineural entrainment and sensorimotor entrainment. Importantly, in Section 3.3, interpersonal studies will show that, despite neural, sensorineural, and sensorimotor systems all evoking periods of emergent organisation with our perceived environments, the sociohistorical world is reaching the limits of contemporary science, as scientists often fail to account for the role of intention. This will be addressed in Chapter 4, as Nishida and Noë will offer a shared response, showing how spontaneous entrainment is a phenomenon that artists can intentionally use to shape the organised activities that shape what we are.

Section 2: Sensorineural Entrainment

Having discussed the anatomy and electrical behaviour of the brain in the previous section, arguing that CFC between neural oscillations can spontaneously initiate and sustain an ORDER system, let us now expand our discussion to include the sensory nervous system

[374] Noë (2015). *Strange Tools*. p.95.

(SNS). Contrary to popular belief—including neuroscientists and many philosophers—we are more than the meat between our ears. We also see, hear, smell, taste, and touch. We speak and get spoken to, hear and get heard. We see light, while also recognising its absence, darkness. The brain and CNS also include a SNS which allows us to perceive and take in the many rhythms our environment affords.

Photoreceptor cells in the eye convert radiated light energy into electrical signals in the brain, as do phonoreceptor cells in the ear with acoustic or kinetic mechanical energy. This is the process of 'sensory transduction,'[375] where our SNS transforms conducted, radiated, convected, and advected energy from our environment into electrical signals in the brain, which then propagate as event-related neural oscillations.

Resting neural oscillations, as previously shown, are measured in relaxed states, such as sleeping or dreaming. These Delta, Theta, and Alpha waves oscillate at a relatively low frequency, typically between 0.5 and 12 Hz, because they are resting neural oscillations and, as such, are not in response to an external stimulus. Beta and Gamma Waves, in contrast, oscillate at a relatively higher frequency, starting at 12 Hz and far exceeding 100 Hz. This is why event-related oscillations are 'recorded during tasks in which stimuli are presented over many trials,'[376] as they are typically in response to energy provided by the external environment via the SNS.

ETMs transfer energy to us from the environment. This gets transformed into electrical signals by the SNS, thereby evoking high frequency event-related neural oscillations that propagate in the brain and CNS. External stimuli, such as sound and light, can evoke high frequency event-related neural oscillations. Low frequency resting neural oscillations are measured in the absence of external stimuli, such as when sleeping or

[375] O'Shea (2005). *The Brain*. p.7.
[376] Mathalon, and Sohal (2015). *Neural Oscillations and Synchrony in Brain*. p.841.

dreaming. To understand how this process can spontaneously initiate and sustain an ORDER system between our brain, SNS, and environment, let us consider examples of acoustic and optical sensorineural entrainment (SNE).

2.1 Acoustic Entrainment

When speaking, our vocalisations radiate acoustic or kinetic mechanical energy. When hearing, this radiated energy travels along the ear canal, causing the eardrum and small bones of the inner ear to vibrate. These vibrations then get transferred to the cochlea, wherein hairs attached to phonoreceptor cells convert them into electrical signals which propagate as event-related neural oscillations in the brain.[377]

In a study by Cirelli et al.,[378] a total of 93 infants were fitted with an EEG and introduced to a rhythmic beat oscillating at a frequency of 3 Hz.[379] The infants were divided into two separate groups, with Experiment 1 consisting of 60 seven month old infants, and Experiment 2 consisting of 33 infants between the ages of 14 to 16 months. During an 18 minute period, Cirelli et al. measured a so called *Steady-state Evoked Potential* (SS-EP) in response to the rhythmic stimuli in both groups.

Colon et al. define a SS-EP as when a 'sustained periodic modulation of a stimulus induces an entrainment of cortical neurons responding to the stimulus.'[380] In other words, a SS-EP response displays a period of emergent synchronisation between the frequency of neural oscillations and the frequency of the received stimulus. Thus, in Cirelli et al.'s

[377] A. James Hudspeth, and Masakazu Konishi (2001). Introduction, In – Proceedings of the National Academy of Sciences, and Masakazu Konishi (2001). *Auditory Neuroscience: Development, Transduction, and Integration (NAS Colloquium)*. Washington, D.C.; National Academies Press. pp. 11690 – 11692.
[378] Cirelli et al. (2016). *Measuring Neural Entrainment to Beat and Meter in Infants*.
[379] Ibid. p.3.
[380] Elisabeth Colon, Valéry Legrain, Gan Huang, and André Mouraux (2015). Frequency Tagging of Steady-state Evoked Potentials to Explore the Crossmodal Links in Spatial Attention Between Vision and Touch, *Psychophysiology*. 52(11), p.1498.

experiments, a SS-EP response suggests that the infants became neurologically entrained with the acoustic stimuli of a rhythmic beat.

Cirelli et al. recognise that, as described in Chapter 2, entrainment is not merely synchronisation, as they explain how 'the SS-EPs elicited in response to the sound do not merely constitute a faithful encoding of the stimulus rhythm. Rather, the brain transforms the rhythmic input by amplifying frequencies that coincide with perceived beat and meter frequencies.'[381] In other words, the evoked neural oscillations were not just *event-related potentials* (ER-Ps), propagating in repose to the energy provided by a rhythmic stimulus. A SS-EP response, in contrast, is when neural oscillations are measured prior to the rhythmic stimulus, becoming increasingly synchronised over time. An ER-P is reactionary and indicative of beat matching. A SS-EP response is anticipatory and indicative of finding and keeping a beat. In short, an ER-P is synchronisation, whereas an SS-EP is a period of emergent synchronisation and entrainment.

It needs noting that an ER-P and SS-EP are both evoked by the SNS in response to an external stimulus. In Cirelli et al.'s experiments, radiated acoustic or kinetic mechanical energy entered infants' ear canals, causing vibrations that got converted into electrical signals that then propagated throughout the brain. While this can explain an ER-P, it cannot explain an SS-EP response. The neural oscillations of infants did not merely track the external rhythm, but rather anticipated and synchronised with it. They did not just match the beat but found and kept it. A SS-EP thus requires further mechanisms and processes. It requires an ORDER system.

The title of Cirelli et al.'s paper, 'Measuring Neural Entrainment to Beat and Meter in Infants,' reveals that they expected to measure a SS-EP response, providing 'direct evidence

[381] Cirelli et al. (2016). *Measuring Neural Entrainment to Beat and Meter in Infants*. p.3.

for the capacity of the infant's brain to entrain, that is, frequency-lock, to incoming auditory rhythms.'[382] While Cirelli et al. did find this, they also made some interesting discoveries. In Experiment 1, it was found that 13 infants that had previous musical training displayed a greater SS-EP response to those infants without.[383] No correlation was found between parents' music training and the displayed SS-EP of infants. Because of this, for Experiment 2, 14 of the 33 infants recruited where randomly selected to take part in musical training for five months prior to experiment taking place. Building upon Experiment 1, researchers expecting those infants with musical training to display a greater SS-EP response, and that parents' musical training would not correlate.

However, much to Cirelli et al.'s surprise, this is not what happened. In Experiment 2, musical training had no notable effect on the measured SS-EP's, whereas '[i]nfants with parents who had at least 5 years of combined music training showed larger amplitudes across SS-EP frequencies than infants without musically trained parents.'[384] Contrary to Experiment 1, this suggests that those infants in Experiment 2 that were likely to have been exposed to music had a greater ability to entrain with rhythmic stimuli than those who had not.

A possible reason for this *may* be due to the age disparity between both groups. In Experiment 1, all infants were 7 months old. In Experiment 2, all infants were between 14 and 16 months old. This was due to the fact that there was 5 months musical training provided for selected infants prior to participating. Cirelli et al. offer two possible explanations:

> It could be that direct musical exposure in the form of infant music classes is more likely to shape meter processing in younger infants, since they have not yet become fully encultured to the metrical structures of the music in their environment, which

[382] Cirelli et al. (2016). *Measuring Neural Entrainment to Beat and Meter in Infants*. p.8.
[383] Ibid. pp.5 – 6.
[384] Ibid. p.8.

> occurs between 6 and 12 months […]. It could also be the case that parents with higher levels of music training, through an interplay of genes and environment, encourage their infants to attend to temporal information in music more than parents with less music training.[385]

In short, meter processing may be influenced by both exposure to music and a caregiver's musical background. As infants develop, this ability becomes increasingly influenced by their caregivers. Admittedly, on this topic, further research is needed. Nevertheless, Cirelli at al.'s study suggests that measured SS-EP increase relative to the amount of exposure infants had to rhythmic stimuli, suggesting that sensorineural entrainment *may* be linked to learning, if not something that can be partially learnt.

2.1.1 Language Discrimination in Newborn Infants

Expanding from neuroscience, behavioural studies in developmental psychology have recognised a similar ability with infants. Newborns are apparently able to distinguish between spoken languages prior to learning the associated complex linguistics and vocalisations. This ability is particularly noticeable when infants are introduced to languages that differ rhythmically and prosodically.[386]

In 'Language Discrimination by Newborns: Toward an Understanding of the Role of Rhythm,'[387] Nazzi et al. performed three experiments. In their first experiment (Experiment 1), Nazzi et al. found that newborn infants from French speaking families, between 1 and 5

[385] Cirelli et al. (2016). *Measuring Neural Entrainment to Beat and Meter in Infants*. p.9.
[386] Lorraine E. Bahrick, and Jeffrey N. Pickens (1988). Classification of Bimodal English and Spanish Language Passages by Infants, *Infant Behavior & Development*. 11(3), pp. 277 – 296; Christine Moon, Robert Panneton-Cooper, and William P. Fifer (1993). Two-day-olds Prefer Their Native Language, *Infant Behavior and Development.* 16, pp. 495 – 500; and Danielle R. Perszyk, and Sandra R. Waxman (2019). Infants' Advances in Speech Perception Shape Their Earliest Links Between Language and Cognition, *Scientific Reports*. 9(1), pp.1 – 6.
[387] Thierry Nazzi, Josiane Bertoncini, and Jacques Mehler (1998). Language Discrimination by Newborns: Toward an Understanding of the Role of Rhythm, *Journal of Experimental Psychology. Human Perception and Performance*. 24(3), Title.

days old, could already discriminate between spoken English and Japanese,[388] both of which fall under two different rhythmic classes. Nazzi et al. placed infants in a specially designed chair, accompanied by an adjustable mechanical arm holding a pacifier linked to a computer. Infants were then introduced to 80 spoken sentences (40 in English, and 40 in Japanese) while their sucking rate on the pacifier was measured. When listening to spoken English sentences, the mean sucking rate per minute was 32.2, dropping to 25 per minute when subsequently introduced to spoken Japanese sentences.[389] As a result of these findings, Nazzi et al. conclude, 'newborns from French speaking families can discriminate English sentences from Japanese sentences.'[390]

In their second experiment (Experiment 2), Nazzi et al. introduced infants from French speaking families to another 80 spoken sentences, this time 40 in English, and 40 in Dutch. These two languages were chosen because they fall under the same rhythmic class, having a similar stress-timed rhythm when spoken.[391] For example, the words "Hello" in English and the word "Hallo" in Dutch both have two syllables, spoken consecutively, and typically with equal intervals between stressed and unstressed syllables. This time, when measuring the mean sucking rate of infants, no significant difference was measured.[392] Thus, in Experiment 2, newborns from French speaking families seemed incapable of discriminating between spoken English and Dutch sentences.

In their final experiment (Experiment 3), Nazzi et al. introduced infants to sentences in English, Dutch, Italian, and Spanish. These four languages were selected because they belong to two rhythmic classes: 'stress-timed English and Dutch on the one hand, [and]

[388] Nazzi et al. (1998). Language Discrimination by Newborns. pp. 758 – 759.
[389] Ibid. p.758.
[390] Ibid. p.759.
[391] Ibid. p. 762.
[392] Ibid. pp. 759 – 761.

syllable-timed Spanish and Italian on the other hand.'[393] Notably, spoken French is also a syllable-timed language. When measuring the sucking rate of infants from French speaking families, Nazzi et al. alternated between rhythmic classes and languages, measuring a noticeable difference in sucking rates as 'the rhythmic group's recovery (+10.9 sucks) was significantly larger than that of the nonrhythmic group (+2.2 sucks).'[394] Experiment 3 aligned with the results of Experiment 2, as infants were still unable to discriminate between spoken English and Dutch, likewise between Spanish and Italian. Experiment 3 also aligned with the results of Experiment 1, as infants were able to distinguish between the stress-timed and syllable-timed languages. Infants could discriminate between rhythmic classes, but not between languages with similar rhythmic patterns.

While the distinction between rhythmic classes in natural languages is widely recognised, as well as being the subject of debate,[395] the relevant point here is that natural languages are typically spoken rhythmically. Nazzi et al. explain: 'In stressed-timed languages, isochrony is supposedly based on the regular occurrence of stressed syllables, whereas in syllable-timed […] languages, isochrony is supposed to rely on syllables [of] equal durations.'[396] As shown, the words "Hello" and "Hallo" both have two syllables, spoken consecutively, and typically with equal intervals between stressed and unstressed syllables; stressed "Hel" or "Hal", then an unstressed "lo." This is a stress-timed rhythmic pattern.

In Spanish and Italian, the greetings "Hola" and "Ciao" have two syllables, spoken consecutively, typically with a stressed to unstressed rhythmic pattern on syllables, and with

[393] Nazzi et al. (1998). Language Discrimination by Newborns. p. 762.
[394] Ibid. p. 762.
[395] Pascale Lidji, Caroline Palmer, Isabelle Peretz, and Michele Morningstar (2011). Listeners Feel the Beat: Entrainment to English and French Speech Rhythms, *Psychonomic Bulletin & Review*. 18(6), p. 1036; and Sha Liu, and Kaye Takeda (2021). Mora-timed, Stress-timed, and Syllable-timed Rhythm Classes: Clues in English Speech Production by Bilingual Speakers, *Acta Linguistica Academica*. 68(3), pp. 350 – 369.
[396] Nazzi et al. (1998). Language Discrimination by Newborns. p. 757.

an equal emphasis on each syllable. In Spanish, the stressed syllable is “Ho,” followed by the unstressed syllable of “la.” In Italian, the stressed syllable is “Cia,” followed by the unstressed syllable of “o.” This is a syllable-timed rhythmic pattern.

Experiment 1 is particularly revealing, as it highlights the significance of spoken Japanese as a mora-timed language. In linguistics, *morae* (the plural of *mora*) are the basic units of timing or the rhythmic intervals in speech. Mora-timed languages emphasise and stress timing, as evidenced by instances where ‘overlap exists between the mora and the syllable.’[397] In Japanese, speakers traditionally segment speech into *haku* 拍, later called *mōra* モーラ. For example, the spoken word “*konnichiwa*” こんにちは (Hello) has three syllables and four *haku*, spoken consecutively, typically with a stressed “*kon*,” “*ni*,” “*chi,*” and the unstressed particle of “*wa*” at the end. Revealingly, “*Kon*” and “*nichiwa*” share a single syllable. This is why the word is often (mis)spelled as “*Kon’nichiwa,*” with the added apostrophe being indictive of an inflection or pause mid-syllable. Similar differences between natural languages are observed in sentence structure, pronunciation, the number of vowels and consonants, as well as, in the case of Japanese, added honorifics such as *keigo* 敬けい語ご (respectful language). Therefore, while the distinction between stress-timed, syllable-timed, and mora-timed languages are more of a general categorisation, with natural languages only differing by degree and often with considerable overlap, there are significant rhythmic differences in speech.

Assuming that newborns between 1 and 5 days old don’t understand complex semantics, such as the meaning of words, Nazzi et al.’s three experiments provided evidence that infants are born ‘sensitive to the rhythmic properties of fluent speech.’[398] Furthermore, as Nazzi et al. conclude, ‘prosody provides enough information to differentiate sentences from

[397] Liu, and Takeda (2021). *Mora-timed, Stress-timed, and Syllable-timed Rhythm Classes*. p. 352.
[398] Ibid. p. 763.

two foreign languages, at least when the languages belong to different rhythmic classes.'[399] Thus, when it comes to language discrimination in newborn infants, it's not what is said that matters, but the rhythm in which it is said.

2.1.2 Vocal Synchronisation Between Infants and Caregivers

Given how Nazzi et al.'s experiments show rhythm to be a contributing factor to language discrimination, it is unsurprising then that rhythm is also contributing factor in many other vocal interactions. For example, in 'A Longitudinal Study of Coordination in Mother-infant Vocal Interaction From Age 4 to 10 Months,'[400] Harder et al. measured the vocal response times between 47 infants and their caregivers. Prior their study, Harder et al. 'hypothesize[d] that both mothers and infants have a dominant covocalizing pattern at 4 months and that both mothers and infants change from this pattern to a predominantly alternating one between 4 and 10 months.'[401] Put another way, it was expected that the vocalisations of caregivers and infants would be initially synchronised, becoming increasingly desynchronised as the infant developed the ability of language.

However, Harder et al. made a surprise discovery, finding that, at four months old, 'only the infants showed this [covocalizing] pattern, whereas the mothers had a predominantly turn-taking pattern.'[402] Caregivers mainly vocalised in response to their infant, whereas the vocalisations of infants became increasingly synchronised with their caregiver. The caregiver's turn-taking patterns was such that the infant would vocalise, then the caregiver, then the infant, the caregiver, and so on. However, this was not the case with the infant. Their vocalisations became increasing synchronised with their care-givers, eventually

[399] Liu, and Takeda (2021). *Mora-timed, Stress-timed, and Syllable-timed Rhythm Classes*. p. 759.
[400] Harder et al. (2015). *A Longitudinal Study of Coordination in Mother-infant Vocal Interaction*.
[401] Ibid. p.1781.
[402] Ibid. p.1786.

covocalizing. Simply put, infants were finding and matching the rhythm offered by their caregivers' vocalisations.

This disparity suggests a deeper and more profound relationship between infant's and caregiver's vocalisations. On one hand, the infant's ability for sensorineural entrainment allows them to synchronise their vocalisations with those offered by a care-giver's rhythmic speech pattern. On the other hand, the care-giver's turn-taking speech pattern provides a rhythmic source of radiated acoustic or kinetic mechanical energy to which the infant can neurologically and vocally entrain. Like the rhythmic beat offered in Cirelli et al.'s experiments, caregivers in Harder et al.'s study offered the rhythmic vocalisations of language directly to the infant's SNS and brain. As expected, this evoked an SS-EP response, as evidenced by the fact that infants displayed an increasing synchronised and entrained vocalising pattern with caregivers.

We will return to this in Chapter 4, Section 3.2, as it suggests that caregivers may have intentionally, if only tacitly, used spontaneous entrainment as a tool to create structures of organisation in infants' brains. This ORDER system, quite literally, offered the rhythms of spoken language to infants, "pulling up" the electrical activity of their brains, strengthening the connections between neurons and lowering their respective thresholds for firing. This aligns with the idea of Hebbian learning discussed in Chapter 2, Section 1.1.1, where neurons that fire together, wire together. Thus, the ORDER system of care-giver's turn-taking speech pattern, combined with an infant's SNS and brain, offered new rhythmic classes to which an infant can neurologically and vocally entrain. In short, it offered the rhythm of language.

2.2 Optical Entrainment

Sound is just one of many stimuli that can have an effect on our sensorineural system. Perhaps the most profound stimuli is that of light. The Earth rotates. Each solar day, the sun

rises in the East and sets in the West. This rhythmic day-night cycle (DN cycle) predates us and, expectedly, will endure long after we are gone. It is one of few constants in our evolutionary and ecological existence.

In the light of day, we wake up, feel alert, and are active. In the dark of night, we feel tired, lethargic, and go to bed. For humans, and many other diurnal animals, 'cycles of alternating light and darkness […] are the most powerful environmental synchronizers of biological rhythms.'[403] They govern nearly all of our essential physiology and metabolism,[404] as well as our physical and mental health,[405] all of which are synchronised to the rhythmic oscillation of a spinning planet in relation to a sun some 149 million kilometres away. This is our circadian rhythm.

There are many stimuli that influence our circadian rhythm, what are often referred to as *zeitgeber* (time giver). These *zeitgeber* can include social cues,[406] body temperature,[407] timed feeding,[408] to name but a few. Yet, the most powerful *zeitgeber* is that of light and darkness. While it varies from season to season, the rhythmic DN cycle offers a relatively consistent oscillation between light and dark in our lives.

2.2.1 The Day-Night Cycle

In light, photoreceptor cells in the retinal ganglion of the eye convert the *zeitgeber* of radiated light energy into electrical signals in the brain, which then propagate as event-related

[403] Czeisler et al. (1981). *Entrainment of Human Circadian Rhythms*. p.240.
[404] Robert Dallmann, Steven A. Brown, and Frédéric Gachon (2014). Chronopharmacology: New Insights and Therapeutic Implications, *Annual Review of Pharmacology and Toxicology*. 54(1), pp.339 – 361; and Oren Froy (2010). Metabolism and Circadian Rhythms—Implications for Obesity, *Endocrine Reviews*. 31(1), pp. 1 – 24.
[405] Michael H. Hastings, Elizabeth S. Maywood, and Marco Brancacci (2018). Generation of Circadian Rhythms in the Suprachiasmatic Nucleus, *Nature Reviews. Neuroscience*. 19(8), pp. 453 – 469.
[406] Matthias Wiss, and Tordjman Sylvie (2016). Creating a 'Social Zeitgeber' to Synchronize Family Emotional Rhythms: A New Therapeutic Approach in Child and Adolescent Psychiatry, *Journal of Physiology*. 110(4), pp. 480 – 486.
[407] Benjamin Coiffard, Aïssatou Bailo Diallo, Soraya Mezouar, Marc Leone, Jean Louis Mege (2021). A Tangled Threesome: Circadian Rhythm, Body Temperature Variations, and the Immune System, *Biology*. 10(1), pp. 1 – 16.
[408] Friedrich K. Stephan (2002). The "Other" Circadian System: Food as a Zeitgeber, *Journal of Biological Rhythms*. 17(4), pp. 284 – 292.

neural oscillations. Upon reaching the hypothalamus, specifically the suprachiasmatic nucleus (SCN), the so called circadian clock,[409] this stimulates endocrine cells and releases hormones into the bloodstream.[410] These chemical messengers, through a process called 'signal conduction,'[411] evoke biochemical responses that can have a dramatic effect on our cognitive and physical lives. The most notable of which is the hormone of cortisol, which, alongside its other stress-related functions, helps us to wake up, stay alert, and be active.

In total or partial darkness, the absence of light, photoreceptor cells in the eye no longer receive the *zeitgeber* of radiated light energy. Nonetheless, darkness is also a *zeitgeber*. This is because the decrease in high frequency event-related neural oscillations reduces the release of hormones, such as cortisol. In the absence of event-related neural oscillations, signal conduction between the SCN and the pineal gland releases the hormone of melatonin which, when combined with resting state oscillations, make us feel tired and lethargic in preparation for sleep.[412] Thus, light and darkness, combined, offer a powerful *zeitgeber* that energetically and hormonally synchronises our SNS and brains with the DN cycle.

Once again, entrainment is not merely synchronisation, nor is synchronisation necessarily entrainment. Our circadian rhythm is much more than a habitual or conditioned response where we synchronise our lives with the DN cycle; it is sensorineural and neurobiological. In 'Generation of Circadian Rhythms in the Suprachiasmatic Nucleus,'[413] Hastings et al. explain that '[s]ynchrony [is t]he temporal order of individual oscillators

[409] Froy (2010). *Metabolism and Circadian Rhythms*. p.2.
[410] Hastings et al. (2018). Generation of Circadian Rhythms. pp. 455 – 456.
[411] Sosuke Ito, and Takahiro Sagawa (2015). Maxwell's Demon in Biochemical Signal Transduction with Feedback Loop, *Nature Communications*. 6(1), pp. 1 – 6.
[412] Yoshiaki Isobe, Junko Fujioi, and Hitoo Nishino (2001). Circadian Rhythm of Melatonin Release in Pineal Gland Culture: Arg-vasopressin Inhibits Melatonin Release, *Brain Research*. 918(1), pp. 67 – 73.
[413] Hastings et al. (2018). Generation of Circadian Rhythms. pp. 453 – 469. Title.

expressing a common period and stable phase relationships,'[414] whereas '[e]ntrainment [is] a process whereby a rhythmic physical or biological cue sets the period and the phase of a circadian oscillation.'[415] In the context of our circadian rhythm, the predominant rhythmic cue is that of the DN cycle, to the extent that it evokes rhythmic event-related and resting-state neural oscillations in the brain. In other words, the SNS enables the frequency of the DN cycle to "pull up" the frequency of neural oscillations. In light, the frequency of neural oscillations increases, in darkness, the frequency decreases. As the DN cycle continues, the electrical activity of the brain becomes increasingly synchronised. Thus, a circadian rhythm is not merely synchronisation, it is the emergent synchronisation between the frequency of the DN cycle and the frequency of neural oscillations.

This is why light keeps us awake, why a good night's sleep requires darkness, and why many "weekend warriors" struggle in work on a Monday morning. It is also why people with insomnia consume synthetic versions of melatonin, and why irregular sleeping patterns present a very real threat to our physical and mental health.[416]

In 2014, a smartphone app called "ENTRAIN" was created by sleep researchers Olivia J. Walch, Amy Cochran, and Daniel B. Forger, being designed to obtain data on global sleeping patterns, specifically the purported 'tug-of-war between solar and social timekeeping.'[417] Extracting data from a total of 8070 users, from 20 different countries and various time zines, ENTRAIN revealed 'that users reporting that they are typically exposed to

[414] Hastings et al. (2018). *Generation of Circadian Rhythms*. p. 455.
[415] Ibid. p. 455.
[416] Till Roenneberg, Karla V. Allebrandt, Martha Merrow, and Céline Vetter (2012). Social Jetlag and Obesity, *Current Biology*. 22(10), pp. 939 – 943; and Laura Cristina Tibiletti Balieiro, Cristiana Araújo Gontijo, Luisa Pereira Marot, Gabriela Pereira Teixeira, Walid Makin Fahmy, Claudia Roberta de Castro Moreno, Yara Cristina de Paiva Maia, and Cibele Aparecida Crispim (2021). Circadian Misalignment Measured by Social Jetlag from Early to Late Pregnancy and its Association with Nutritional Status: A Longitudinal Study, *Scientific Reports*. 11(1), pp. 1 – 13.
[417] Olivia J. Walch, Amy Cochran, and Daniel B. Forger (2016). A Global Quantification of "Normal" Sleep Schedules Using Smartphone Data, *Science Advances*. 2(5), p. 5.

outdoor light go to sleep earlier and sleep more than those reporting indoor light.'[418] These findings add further nuance, suggesting that the type of light people are exposed to can have different results, with exposure to natural light being more conducive to a healthy sleeping pattern than artificial light. There is much to unpack here, as the effects of different kinds of light on sleep, specifically blue light, is often overstated.[419] The relevant point is that our synchronisation with the DN cycle has a profound effect on our physical and mental health, be it beneficial or detrimental.

2.2.2 Jet-lag

A poignant example of how these detrimental effects is flight dysrhythmia, commonly known as jet-lag. While this experience can vary from person to person, depending on factors such as the difference between time-zones and direction of travel, jet-lag is when individuals become cognitively impaired when entering a new time-zone, feeling a kind of mental fog, lethargy, or disorientation.

However, if rescheduling were the only contributing factor to jet-lag, then it would be a relatively brief and easy experience. This is often not the case. When experiencing jet-lag, we cannot just intentionally get over it. It takes time. To overcome jet-lag, we need to match our behaviours and sleeping patterns to the new time zone in order to feel remotely ourselves again. It also requires that we reacclimate and re-entrain ourselves to the new DN cycle, both socially and neurobiologically. This is why some long-distance, short-stay, travellers claim that they avoid jet-lag by staying on the same time schedule as their original location, refusing to synchronise with their current locations social cycle. For longer stays, short of hiding in one's basement, jet-lag will inevitably set in. It can take several days to recover

[418] Walch et al. (2016). *A Global Quantification of "Normal" Sleep Schedules*. p. 1.
[419] Laura E. Downie, Sumeer Singh, Peter R. Keller, Ljoudmila Busija, Patrick McMillan, Eve Makrai,; John G. Lawrenson, and Christopher C. Hull (2023). Blue-light Filtering Spectacle Lenses for Visual Performance, Sleep, and Macular Health in Adults, *Cochrane Database of Systematic Reviews*. 2023(8).

from, having persistent symptoms such as anxiety, fatigue, constipation, diarrhoea, lack of focus, memory loss, nausea, and a general experience of feeling unwell.[420] This is why jet-lag is classified as a disorder or syndrome; it is not merely a matter of habit or behaviour.

This is largely because of how we are neurological and hormonally entrained. The new time-zone and DN cycle spontaneously initiates and sustains a period of entrainment or, more precisely, re-entrainment. For example, when flying form Dublin in Ireland to Tokyo in Japan, a traveller is already neurobiologically, hormonally, and energetically entrained to the rhythmic frequency of Ireland's DN cycle. When arriving in Tokyo, the traveller finds themselves neurobiologically, hormonally, and energetically out of sync with Japan's DN cycle. As the new DN cycle continues, the rhythmic oscillation between light and darkness, combined with the travellers SNS and neural oscillations, evoke an increased synchronisation between their brain and the new time-zone. Even of the traveller immediately matched the Tokyo's social cycle, it still requires an acclimation to the new DN cycle to truly get over jet-lag. Put another way, the frequency of Tokyo's DN cycle "pulls up" the frequency of the traveller's brain, which was already synchronised to the frequency of Ireland's DN cycle. Thus understood, recovering from jet-lag is primarily a process of re-entrainment to a new DN cycle, while also being reinforced by social cycles, exemplifying how, as will be shown in Chapter 4, entrainment can be instantiated in the material, biological, and sociohistorical world.

2.3 Additional Features

The example of jet-lag highlights some additional features that have not previously been discussed. In Chapter 2, Section 2, when describing a murmuration of starlings as an

[420] Robert L. Sack, Dennis Auckley, R. Robert Auger, Mary A. Carskadon, Kenneth P. Wright, Michael V. Vitiello, and Irina V. Zhdanova (2007). Circadian Rhythm Sleep Disorders: Part I, Basic Principles, Shift Work and Jet Lag Disorders: An American Academy of Sleep Medicine Review, *Sleep*. 30(11), pp. 1460 – 1483; and Karol Mazur, Dominik Machaj, Dominika Mazur, Aneta Asztabska, and Alicja Płaczek (2020). The Use of Melatonin in the Treatment of Jet Lag – Clinical Review, *Journal of Education, Health and Sport.* 10(5), p.175.

ORDER system, two ways of understanding this phenomenon were offered. From the top down and from the bottom up. This exemplifies Gillett's 'machretic determination,'[421] as well as upward and downward entrainment. However, the jet-lag shows that entrainment can also be solely from the top down. This is downward entrainment, where the whole "pulls up" the frequency of parts, without upward entrainment, where the parts "pull down" the frequency of the whole. In other words, there can be downward entrainment with no corresponding upward entrainment.

As shown, our neurobiology is entrained, and thus synchronised, with the DN cycle. From the top down, the rhythmic energy offered by the DN cycle "pulls up" the frequency of neural oscillations to match. Yet, neural oscillations have no meaningful effect on the DN cycle. There is little, if any, upward entrainment between the electrical activity of the brain and the rotation of the Earth, even less with a sun over 1 million times the Earth's mass and some 150 million kilometres away. While, like everything else in the universe, our neurons, brains, SNS, and bodies are open energy systems, transferring and receiving energy with our environment, the asymmetry between us and the energy and mass involved in the DN cycle is vast. So vast in fact, that ORDER system and emergent synchronisation is solely a process of downward entrainment.

This additional feature shows that while the emergent synchronisation in an ORDER system can be mutual, as with CFC, this is not necessarily so. The emergent synchronisation in an ORDER system can also be one-sided. This is particularly noticeable with the experience of jet-lag, as the new time-zone is energetically and hormonally "pulling up" the frequency of our SNS. When a person arrives in a new time-zone, the frequency of the new DN cycle and their neural oscillations are out of sync, in the sense that their sensorineural system is already entrained to the DN cycle from which they are departing.

[421] Gillett (2016). *Reduction and Emergence*. p.234.

Given that recovery from jet-lag can take place over several days, varying from person to person, as well as being reinforced by social cycles and cues, it is extremely difficult for EEG studies to track the associated changes in the brain. In lieu of this, researchers typically take a computational approach, modelling the re-entrainment between neural oscillations with new DN cycles.[422] Nevertheless, as the new DN cycle rhythmically transfers energy, the SNS transforms this into electrical signals that "pull up" the frequency of neural oscillations. As this process continues, the electrical activity of the brain becomes increasingly synchronised with the new DN cycle. This is also the case in the previous experiments looking at vocal entrainment, as the rhythmic vocalisations of a care-giver "pulled up" those of an infant, even when the vocalisations of an infant did not "pull down" those of a care-giver. Therefore, an ORDER system can involve upward or downward entrainment, although not necessarily together.

2.4 Summary and Context

In summary, SNE is an ORDER system. The SNS is an open energy system, as is the perceived world. All energy and mass transfer and absorb energy. There is no such thing as a perfectly closed energy system, bar possibly the entire universe. The perceived world transfers energy directly to the SNS, getting transformed into electrical signals by way of sensory transduction. If the SNS were not an open system, them this could not occur. Evidently there is an asymmetry here, as the SNS does not transfer energy to the perceived world in any meaningful way. Although, as will be shown in the next section, this changes dramatically when the SNS is combined with the sensorimotor system.

[422] Albert Goldbeter, and Jean-Christophe Leloup (2021). From Circadian Clock Mechanism to Sleep Disorders and Jet Lag: Insights From a Computational Approach, *Biochemical Pharmacology*. 191(0), pp. 1 – 16.; and Hiroshi Kori, Yoshiaki Yamaguchi, and Hitoshi Okamura (2017). Accelerating Recovery From Jet Lag: Prediction From a Multi-oscillator Model and its Experimental Confirmation in Model Animals, *Scientific Reports*. 7(1), pp.1 – 10.

The SNS is also a resonating system. Perceived natural frequencies, such as rhythmic sounds and the DN cycle, energetically “pull up” the natural frequency and of the SNS and brain. Saying that the SNS and DN cycle, for example, both have a similar natural frequency can sound odd. However, it is not just that DN cycle has a similar natural frequency to our brains, which it does, but that our brains have a similar natural frequency to the DN cycle. This is a subtle yet important difference. The energy provided by the sun has been instrumental in our evolution, continuing to make life possible on Earth. Given this evolutionary and ecological fact, it is unsurprising that our SNS and brains share a natural frequency with the DN cycle, as well as the many other natural frequencies of our perceived environment.

The SNS is also a dissipating system, being subject to the very same laws of thermodynamics and entropy as the perceived world. All couplings between open systems must end, as must any resonance between. This is a basic fact about the universe. Our SNS is part of a wider energy system that includes the brain, body, and world. Accordingly, the many ETMs we share with the world, perceived and otherwise, contribute to the rapid dissipation of energy.

The SNS is also an emergent system, in the sense that energy provided by the perceived world “pulls up” the natural frequency of the brain. This downward resonance initiates and sustains a period of emergent synchronisation. The SNS and brain become increasingly synchronised with the perceived world for as long as they remain coupled. A paradigm example of this is Jet-lag, where downward resonance from the new DN cycle initiate and sustains a period of emergent sensorineural synchronisation.

The SNS is also a rhythmic system, as is much of the perceived world. The collective electrical behaviour of neurons displays a recurring, periodic, and oscillating pattern. The

rhythmicity and amplitude of neural oscillations can be modified by CFC, as can they when displaying a SS-EP response to a perceived rhythm. The perceived world also displays recurring, periodic, and oscillating patterns, such as vocalisations, language, and the DN cycle. This will be expanded upon considerably in the next section.

In context, this exemplifies how, within Nishida and Noë's world of action and organisation, ORDER systems are considerably more complex in the biological realm than those found in the material. Like neural entrainment, SNE highlights the ambiguity and interplay between humans and their environments. Importantly, it also shows that the emergent synchronisation of an ORDER system need not be mutual, simultaneously involving both downward and upward entrainment. An ORDER system can also be solely from the top down, in the sense that '[p]arts behave differently in wholes,'[423] and not vice versa. SNE is an ORDER system that "pulls ups" our neurobiology, often synchronising our brains, SNS, and lives with powerful rhythms on which we have little, if any, effect. Like *kōiteki chokkan*, where '[w]hat we do shapes what we are, shapes the world that in turn shapes us,'[424] the DN-cycle spontaneously shapes what we do, yet what we do does not shape the DN-cycle. While we can, to some extent, intentionally shape our relationship with the DN-cycle, for example, flying to different time zones or exposing ourselves to different forms of light, this is not spontaneous entrainment. Therefore, while SNE provides a concrete mechanism for understanding how the world of action and organisation applies to our brains and perceived environments, it also highlights, once again, how entrainment in the sociohistorical realm is far more complex than it is in the material and biological.

In the following section, this will be further complicated by recognising that, combined with our brains and sensorineural systems, we humans also have sensorimotor

[423] Gillett (2016). *Reduction and Emergence*. p.201.
[424] Maraldo (2017). *Japanese Philosophy in the Making*. p.199.

systems. In the sociohistorical world, what we can and will do is shaped by an environment that includes other people. In this way, entrainment is only part of the picture, as Chapter 4 will show that intention has a vital role to play. Entrainment is an instantiation of the world of action and organisation, wherein humans spontaneously and intentionally organise and get organised. This will be shown to be something that artists are tacitly aware of, as they can intentionally use spontaneous entrainment as a tool to shape the world that shapes what we are.

Section 3: Sensorimotor Entrainment

Let us now expand our discussion further to include the sensorimotor system. This is because humans both act in and get acted upon by the world that includes other people. We are not inanimate objects, passively receiving stimuli from our environments. Our actions shape our perception, and perception can shape our actions. The perceived spatial dimensions of our environment offer a myriad of actions, such as sitting down, walking, and even dancing. Combined, our neural, sensorineural, and sensorimotor systems entail action and movement.

Sensorimotor entrainment (SME) is a well-recognised phenomenon, if only referred to as sensorimotor synchronisation (SMS) at times. For example, in 'Sensorimotor Synchronization: A Review of Recent Research,'[425] Repp and Su cite 21 sources with the word "entrainment" explicitly stated in the title, as well as using the term 66 times in their own text. Yet, while comprehensive, Repp and Su's review never explicitly addresses the fact that SMS is an emergent property of SME.

This conflation of terms is consistent in Repp's work, as eight years earlier, in 'Sensorimotor Synchronization: A Review of the Tapping Literature,' Repp concludes his

[425] Repp, and Su (2013). *Sensorimotor Synchronization: A Review of Recent Research.* pp.403 – 452.

paper by stating that 'responses effectively became entrained by the stimuli.'[426] While this conflation of terms is not necessarily incorrect, nor are Repp and Su the only ones to do so, it fails to recognise that SMS is an emergent feature of SME. As should be evident by now, entrainment is not merely synchronisation. This will become increasingly problematic as we look at interpersonal studies in Section 3.3 to follow, as researchers often attribute meaningful connections in and between brains when they only identify synchronisation.

Setting this issue aside for the moment, Repp and Su's literature review still provides a robust framework for investigating SME. This is because they identify four common approaches taken by researchers studying SME: 1. Tapping studies, 2. Movement studies, 3. Interpersonal studies, and 4. Neurobiological studies.[427] Having discussed the fourth in Sections 1 and 2 of this chapter, let us then consider examples of SME in tapping, movement, and interpersonal studies.

3.1 Tapping Studies

Over the last century, at least, tapping studies have measured people's ability to synchronise movement, typically a tapping finger, in correspondence with rhythmic stimuli, typically an acoustic rhythm.[428] According to Repp, 'there are many variants […] arising from different forms of movement (e.g., tapping on a hard surface vs. finger flexion or limb movement without contact), different modalities of stimulation (e.g., auditory or visual), and different forms of coordination.'[429] This "tap-to-beat" methodology measures the time between movement and a perceived stimuli, allowing researchers to investigate the complex interplay of neural, sensorineural, and sensorimotor coordination.

[426] Repp (2005). *Sensorimotor Synchronization: A Review*. p.970.
[427] Repp, and Su (2013). *Sensorimotor Synchronization: A Review of Recent Research.* p.403.
[428] Repp (2005). *Sensorimotor Synchronization: A Review*. p.969.
[429] Ibid. p.969.

All tapping studies share a common interest: downward entrainment. When researchers instruct participants to synchronise their movements with a beat, their main interest is in measuring how the perceived stimuli "pull up" the action. Even if tapping studies were set up in such a way that the frequency of the movement could also "pull down" the frequency of the rhythmic stimulus, this would still be entrainment. However, this would move the focus away from the individual. As will be shown in Section 3.3 of this chapter, this kind of upward and downward entrainment is often the focus of interpersonal studies. Tapping studies, in contrast, exclusively focus on how perceived rhythmic stimuli can "pull up" the rhythmic movements of individuals.

3.1.1 Audible Acoustic Rhythms

Historically, the most common stimuli used in tapping studies has been auditory, most often in the way of a rhythmic sound provided by a metronome. The rhythmic clicking sound of a metronome radiates acoustic or kinetic mechanical energy. This enters the ear canal, causing the eardrum and inner ear to vibrate, getting converted into electrical signals by sensory or phonoreceptor cells and propagating as neural oscillations in the brain.

While music might seem like a better stimulus to use, given that most of us are familiar with finding and keeping a beat with it, music can lack the rhythmic consistency required for these studies. This is because composers often intentionally play with expected rhythms so as to evoke a spontaneous response in listeners. For example, Bernard Herrmann's music for the shower scene in Alfred Hitchcock's *Psycho*,[430] borrowed by John Williams fifteen years later for his ominous theme to the movie *Jaws*.[431] In both compositions, the composers offer the "safety" of a slow and consistent rhythm before,

[430] Anthony Perkins, Vera Miles, John Gavin, Martin Balsam, John McIntire, Janet Leigh, Alfred Hitchcock, and Robert Bloch (1960; 2003). *Psycho*. Universal City, CA: Universal Home Video.
[431] Peter Benchley, Carl Gottlieb, Richard D. Zanuck, David Brown, Steven Spielberg, Robert Shaw, Roy Scheider, Richard Dreyfuss, Lorraine Gary, Murray Hamilton, Jeffrey C. Kramer, and Susan Backlinie (1975; 2000). *Jaws*. Universal City, CA: Universal.

suddenly, switching rhythms in a jarring manner. While these two compositions can spontaneously evoke a physical reaction in listeners, especially when combined with startling imagery, this is an event related response akin to sensorimotor startlement, not SME. This is why tapping studies have historically opted for the use of a simple and consistent rhythms provided by a metronome as it oscillates between sound (1) and silence (0).

Additionally, the most common movement measured in tapping studies has, historically, been a tapping finger. Although, it should be noted, recently studies have started to measure 'synchronized circle drawing, gait, dancing, and eye movements,'[432] to name but a few. Focusing on finger tapping studies, for the moment, participants are asked to tap their finger either in-phase (on 1) or antiphase (on 0) with the sound of a metronome.[433] This is because, when moving a finger, the primary motor cortex in the precentral gyrus region of the brain sends electrical signals, via motor neurons, to effector cells in the muscles and tendons responsible for moving a finger. Thus, what may seem like a relatively simple task to many, tapping a finger to a beat, is a complex process where energy from the environment gets transformed into electrical signals in the brain, and where electrical signals in the brain give rise to actions.

For example, a study by Chen et al. measured the brain activity of 24 participants, divided into two groups of twelve, each containing six females and six males.[434] Placed in an fMRI while listening to three different acoustic rhythms, participants were instructed to actively listen and tap their finger to the provided rhythmic beat during an active listening phase, followed by a passive listening phase where they were instructed to remain relatively still. In Chen et al.'s experiment, the active listening stage primed (possibly entrained)

[432] Daniel C. Comstock, Michael J. Hove, and Ramesh Balasubramaniam (2018). Sensorimotor Synchronization with Auditory and Visual Modalities: Behavioral and Neural Differences, *Frontiers in Computational Neuroscience*. 12(53), p.1.
[433] Repp (2005). *Sensorimotor Synchronization: A Review*. p.970.
[434] Joyce L. Chen, Virginia B. Penhune, and Robert J. Zatorre (2008). L*istening to Musical Rhythms Recruits Motor Regions of the Brain*, *Cerebral Cortex*. 18(12), p.2849.

participants' brains for the passive listening stage. Chen et al. observed activity in motor regions of the brain even when there was no corresponding movement:

> motor regions […] resonate in response to sounds that do not bear any obvious significance for action implementation. [Suggesting] an inherent coupling between action--perception processes whereby the motor system is sensitive to and thus driven by properties of the auditory stimulus under certain conditions.[435]

In short, motor regions of the brain responded to the acoustic rhythmic stimuli provided, even in the absence of the corresponding movement. This, Chen et al. speculate, 'may partially explain the often irresistible urge to tap to the beat upon hearing a piece of music.'[436]

Evidently, more research is needed on this specific topic, as there seems to be an element of priming involved in Chen et al.'s study. That active listening stage essentially primes the passive listening, potentially increasing participants' urge to tap their feet that they have already been tapping. The relevant point is that movement and perception are intrinsically linked, and that measuring the time between tap and perceived beat can offer new neurobiological insights. This is the very reason why tapping studies remain of such interest to researchers.

When measuring the time between movement and perceived stimuli, Repp explains that 'each tap may be regarded as the response to a preceding tone, it is a *timed* response that is delayed so as to coincide approximately with the next tone. This distinguishes SMS from a simple reaction time task, where the response is made as quickly as possible.'[437] Repp is saying here that the tapping a finger is not just a reaction to the event of a stimulus, as in participants hear a beat, and then rapidly tap their finger in response. This would be event

[435] Chen et al. (2008). *Listening to Musical Rhythms.* p.2849.
[436] Ibid. p.2853.
[437] Repp (2005). *Sensorimotor Synchronization: A Review*. p.971.

related response, where beat precedes tap, similar to an ER-P in the brain, where a received stimulus precedes a neural oscillation.

However, in tapping studies, taps are often measured prior to the beat, with the time between tap and beat gradually decreasing as synchronisation emerges. In other words, participants hear a beat, wait, and then tap their finger so that it corresponds with the next beat. This continues until tap and beat are closely synchronised. The reason for this is due to the fact that the steady-state rhythmic beat provides consistent stimuli that participants can find and keep with their tapping finger. This is a steady-state evoked response, similar to a SS-EP in the brain, where tap precedes beat.

To complicate things even further, researchers sometimes ask participants to tap their finger out of sequence, as in, tapping their finger on, say, every third 1 or 0. Additionally, researchers can use rhythms with far more complex and varied tempos to that provided by a simple metronome. These can include sounds, such as beeps, clicks, tones, and spoken words. Yet, in all instances, participants are asked to find and keep an acoustic beat with a tapping finger, with researchers consistently measuring a steady state evoked response where tap precedes beat, thereby providing direct evidence of SME. So ubiquitous are these findings over the last century that it is a truism to say that average human can find and keep an acoustic rhythm with a tapping finger. More importantly, this ability can be learnt, improved, and manipulated with practice. As will be shown, experienced musicians typically have a greater ability to find and keep a beat with a tapping finger. Because of this, tapping studies often presuppose SME, allowing researchers to investigate the very limits of this ability.

One limit which is of particular interest to researchers relates to tempo. Studies regularly find that the ability to find and keep a beat with a tapping finger is relative to the speed of the stimuli.[438] Repp explains that studies typically find that

> [w]hen metronome [oscillations] exceed about 1.8 sec, prediction becomes increasingly difficult, and responses begin to lag behind their respective target events. [W]hen responses can no longer be timed accurately enough to coincide with the next tone, some responses turn into simple reactions to that tone.[439]

Participants can find and keep the beat with a tapping finger at high tempos, but often struggle to do so at relatively lower tempos. At lower tempos, participants give event-related responses, hearing a beat and then rapidly taping their finger. A possible reason why researchers do not look at on how people struggle to entrain with higher tempos may be that, at faster speeds, auditory perception in humans shifts from distinct rhythmic pulses to a more continuous sound, which might be perceived as pitch or tone rather than a clear and distinct rhythm. Nevertheless, while there are many contributing factors to this, such as biomechanical and neurobiological limitations, the ability for SME between a tapping finger and rhythmic beat appears relative to tempo. In short, the slower the acoustic tempo, the harder it is to find and keep the beat with a tapping finger.

However, this differs from person to person. Similar to Cirelli et al.'s study, which found that '[i]nfants with parents who had at least 5 years of combined music training showed larger amplitudes across SS-EP frequencies than infants without musically trained parents,'[440] finger tapping studies frequently find that participants with music training exhibit

[438] See - Nozaradan et al. (2016). *Individual Differences in Rhythmic Cortical Entrainment*. pp.1 – 12; and Michael H. Thaut, Robert A. Miller, and Leopold M. Schauer (1998). Multiple Synchronization Strategies in Rhythmic Sensorimotor Tasks: Phase vs Period Correction, *Biological Cybernetics*. 79(3), pp.241 – 250.
[439] Repp (2005). *Sensorimotor Synchronization: A Review*. p.971.
[440] Ibid. p.8.

an increased ability for SME at higher tempos compared to those without.[441] Taken together, these findings suggest that practice and training can improve our ability for SME. Simply put, SME is something we can all do and, crucially, something we can get better at with practice.

3.1.2 Visual Rhythms

Another common stimulus used in tapping studies is visual, typically in the form of a rhythmic flashing light, image, or written word. Recently, studies have even started to ask participants to view oscillating devices, such as a pendulum or metronome.[442] Again, what seems like a relatively simple task to many, tapping a finger to a visual rhythm, is a complex process where energy from the environment gets transformed into electrical signals in the brain, and where electrical signals in the brain give rise to movement. As with audible rhythms, measing the timing between a visual rhythm and a rhythmic movement allows researchers to investigate the neurobiological link between action and perception.

Tapping studies that use visual stimuli can offer rhythms of varied complexity, asking participants to tap their finger either in-phase or anti-phase with the provided stimuli. However, unlike audible rhythms, higher tempo visual rhythms are known to evoke seizures and more general feelings of discomfort, as seen with the example of *Pokemon Shokku* in Japan in 1997, as with epilepsy trigger warnings that are quite commonplace. To account for this, researchers offer visual rhythms at a relatively low tempo.

Yet, in all of these studies, researchers once again presuppose an ability for SME, looking for evidence of downward entrainment where the perceived rhythm "pulls up" the movements of participants. Furthermore, as with acoustic rhythms, researchers consistently

[441] Repp (2005). *Sensorimotor Synchronization: A Review*. p.8.
[442] Armstrong, and Issartel (2014). *Sensorimotor Synchronization with Audio-visual Stimuli*. pp.3453 – 3463.

measure a steady state evoked response, where tap precedes stimuli, once again providing direct evidence of SME.[443]

This is not to say that the SME and steady state evoked responses elicited by perceived audible and visual rhythms are identical. Researchers often find a discrepancy between the two. For example, in 'Rate Limits in Sensorimotor Synchronization With Auditory and Visual Sequences,'[444] Repp designed a series of experiments that aimed to discover the upper limits of SME, as well as how this might vary between audible and visual rhythms. To do so, Repp measured 12 participants' ability to find and keep acoustic and visual rhythms of different tempos with a tapping finger, finding that '[t]he visual synchronization threshold […] was about 4 times as high as the auditory one.'[445] This indicates that the threshold for a steady state evoked response was far higher with visual stimuli than it is with audible. Participants were able to find and keep a visual rhythm at a much higher tempo than they could with an audible rhythm. Thus, while a study with just 12 participants is not conclusive, Repp's findings suggests that the ability for SME between a tapping finger and rhythmic beat is relative to tempo, and this can vary between acoustic and visual stimuli.

Repp's findings align with a later study by Ono et al., 'Keeping an Eye on the Conductor: Neural Correlates of Visuo-motor Synchronization and Musical Experience.'[446] Ono et al. created a finger tapping study with the aim of measuring the SME between

[443] Bruno H. Repp (2003). Rate Limits in Sensorimotor Synchronization With Auditory and Visual Sequences: The Synchronization Threshold and the Benefits and Costs of Interval Subdivision, *Journal of Motor Behavior*. 35(4), pp.355 – 370; Repp (2005). *Sensorimotor Synchronization: A Review*. pp. 969 – 970; Alan M. Wing, Michail Doumas, and Andrew E. Welchman (2010). Combining Multisensory Temporal Information for Movement Synchronisation, *Experimental Brain Research*. 200(3-4), pp.277 – 282; Kentaro Ono, Akinori Nakamura, and Burkhard Maess (2015). Keeping an Eye on the Conductor: Neural Correlates of Visuo-motor Synchronization and Musical Experience, *Frontiers in Human Neuroscience*. 9(154), pp.1 – 12; and Yi Huang Su (2016). Sensorimotor Synchronization with Different Metrical Levels of Point-light Dance Movements, *Frontiers in Human Neuroscience*. 10(2016), pp.1 – 15; and

[444] Repp (2003*). Rate Limits in Sensorimotor Synchronization With Auditory and Visual Sequences*. Title.

[445] Ibid. p.361.

[446] Ono et al. (2015). *Keeping an Eye on the Conductor*. pp.1 – 12

participants and rhythmic visual stimuli, specifically when watching an orchestra conductor and when watching a metronome. Eleven participants were selected, all classically trained musicians, as well as another fourteen participants with no musical training. All participants were then provided with video footage of a conductor gesturing and of a metronome oscillating, both having the same rhythmic pattern and played without any accompanying sound.

Importantly, Ono et al. were not just measuring the upper limits of SME like Repp previously did. They were also examining the ability itself. Specifically, how steady state evoked responses may vary with previous exposure and expertise. Ono et al. write:

> Musicians performed tapping under a conductor with more precision than nonmusicians. […] Conversely, tapping with the metronome did not show any difference between musicians and nonmusicians, indicating that the expertize effect in tapping under the conductor does not result in a general increase in tapping performance for musicians.[447]

In other words, a similar response was measured with all participants when viewing a metronome, whereas trained musicians displayed a greater ability to synchronise with a perceived conductor than those without.

This is significant finding, as the composer and metronome were providing the same rhythm, and yet musicians were able to synchronise with a conductor with greater precision than non-musicians. Musically trained participants exhibited a greater ability for SME with a conductor when compared to non-trained participants, despite both groups showing similar abilities for SME with a metronome. While, colloquially, saying that musicians are better at playing music with a conductor that non-musicians is as one would expect, Ono et al.'s study

[447] Ono et al. (2015). *Keeping an Eye on the Conductor*. p.1.

suggests a deeper neurobiological foundation. Thus, in Ono et al.'s study, previous exposure and practice with a conductor increased the musician's capability for SME, supporting the idea that SME is an ability that improves with practice.

3.2 Movement Studies

Movement studies have much in common with tapping studies, to the extent that they also investigate our ability to synchronise rhythmic movements with perceived rhythmic stimuli. Both studies look for movement prior to stimulus, where participants perceive a stimulus, wait, and then move to correspond with the next stimulus, and so on. However, movement studies are much more expansive in scope, looking for SME and emergent SMS with many 'other forms of moving in synchrony with external rhythms […] including dance and nonhuman animals.'[448] This ability for 'Rhythmic Entrainment,'[449] as it is often called, is when we synchronise our bodily movements with a perceived rhythm. Like tapping a finger to a rhythmic beat, we can find and keep the beat of rhythms with the rhythmic movements of our body.

3.2.1 Dancing Babies

Babies' vocalisations are often accompanied by movement. When happy or content, infants make cooing and gurgling sounds. When in distress, they cry. These vocalisations are naturally accompanied by movements, such as energetically wiggling their upper torso and limbs, kicking, and flailing their arms and legs, and so forth. To the relief of caregivers, rhythmically sucking on a pacifier can be enough to either comfort or distract an infant.

In 'Rhythmical Behavior in Infancy: An Ethological Perspective,'[450] Esther Thelen created a movement study looking at the movements of 20 infants, starting at four weeks old

[448] Repp, and Su (2013). *Sensorimotor Synchronization: A Review of Recent Research.* p.403.
[449] Wilson, and Cook (2016). *Rhythmic Entrainment*. Title.
[450] Esther Thelen (1981). Rhythmical Behavior in Infancy: An Ethological Perspective, *Developmental Psychology*. 17(3), pp. 237 – 257.

and ending at the age of one. Every second week, researchers visited infants in their homes and noted 'movements of parts of the body or the whole body repeated in the same form at least three times at regular short intervals of about a second or less.'[451] Simply put, researchers noted rhythmic movements. At the end of this study, it was discovered that all infants displayed an inherent rhythmicity with their movements. So strong was this tendency that, as Thelen puts it, each 'infant appeared to be following the dictum, "If you can move it at all, move it rhythmically."'[452]

A powerful rhythmic stimulus in an infant's life is their caregiver. Upon seeing a happy or content infant, caregivers can respond by rhythmically singing, shaking rattles, reading stories and nursery rhymes, and speaking "baby talk" (also known as "Parentese"). In fact, "baby talk" often has a greater rhythmic consistency that other naturally spoken languages, as caregivers typically vocalise in a comparatively simpler and repetitive manner. Furthermore, when seeing or, more likely hearing, an infant in distress, caregivers can respond by picking the infant up, offering a rhythmic rocking motion and making comforting rhythmic sounds like shushing and humming. Accordingly, infants and caregivers both display an inherent rhythmicity with their vocalisations and movements, oftentimes in response to each other. Thus, movement studies are justified in looking for SME between infants and caregivers.

For the movements of an infant to be considered an instantiation of SME, the synchronisation must be emergent. In other words, SMS must not be an event related response, as in the infant perceives a rhythmic stimulus, and then moves in swift succession. A clear example of this would be the game peek-a-boo, where a caregiver "disappears" by covering their face with their hands and, much to the infant's amazement, "reappears" again

[451] Thelen (1981). *Rhythmical Behavior in Infancy*. p.238.
[452] Ibid. p.239.

by showing their face. The reason that this game evokes an event-related response in an infant is due to the fact that young infants lack the ability for object permanence.[453] This means that the infants surprise each time their caregiver "reappears" is quite real and event related, in the sense that the stimulus precedes the reaction.

For peek-a-boo to be deemed SME, the reaction must precede the stimulus. The infant must see their caregiver "disappear," wait, and then react so that it corresponds with the "reappearance," continuing until both stimulus and reaction are closely synchronised. This would be a steady state evoked response, similar to a SS-EP in the brain and those measured in finger tapping studies, and one which infants typically develop around the age of one.[454] So, while movement studies are well justified in looking for SME between an infants and caregivers, the emergent SMS must be a steady state evoked response, not event-related. In short, movement must precede stimulus.

As discussed in Section 2. of this chapter, Cirelli et al. provided direct evidence for SNE between an infant and a provided acoustic rhythm. In Section 2.1.1, Nazzi et al. also indicated that, when it comes to language discrimination, it is not what is said to newborn infants that matters but the rhythm in which it is said. Because of such findings, movement studies interested in SME between infants and caregivers often use much more complex rhythmic patterns and sequences than those previously discussed. Music, singing, and dancing are the most common, with researchers measuring the time between the infant's action and stimuli.

[453] Henry M. Wellman, David Cross, Karen Bartsch, and Paul L. Harris (1987). Infant Search and Object Permanence: A Meta-analysis of the A-not-B Error, *Monographs of the Society for Research in Child Development.* 51(3), pp. i – 67.

[454] There is debate about when exactly an infant develops the capacity for object permanence. See - Trix Cacchione (2013). The foundations of object permanence: Does Perceived Cohesion Determine Infants' Appreciation of the Continuous Existence of Material Objects?, *Cognition*. 128(3), pp. 397 – 406.

In a movement study looking at this very thing, Merker et al. recorded footage of 25 infants at home with caregivers at the ages of 6, 9, and then 12 months old. No explicit instructions were given to caregivers about how they were to interact with infants, and all participants were unaware of the purpose of the study, being to investigate 'the role and origin of isochrony in human rhythmic entrainment.'[455] Researchers studied the effect of *isochrony* (another name for the rhythmic classes of natural spoken languages) by doing a frame-by-frame analysis of the footage, a total of 120 hours. Merker et al. found that caregivers regularly attempted to engage with infants rhythmically, typically in the form of dancing, singing, or music.[456] Yet, with the exception of just one child, no evidence of SME between infants' movements and caregivers was found.[457]

While the 25 infants did react to the perceived rhythmic movements and vocalisations for caregivers, often kicking and flailing their limbs in excitement, only one appeared to give a steady state evoked response, the responses of the remaining 24 were merely event related. Merker et al. explain:

> Social situations of music and dancing tend to excite infants, who may even perform repetitive gestures that are recognisably patterned on those of adults dancing. In this sense the infant is in fact ''dancing'', though without the temporal yoking of body movements to the tactus of the music that is the crux of rhythmic entrainment.[458]

What Merker et al. are saying here is that, with the exception of just one infant, stimuli preceded action. Like in the game of peek-a-boo, infants were responding excitedly to their caregivers. They were not waiting to react in correspondence with the next stimulus. The reason for this, Merker et al. suggest, is because '[t]he erratically segmented nature of infant

[455] Merker et al. (2016). *On the Role and Origin of Isochrony in Human Rhythmic Entrainment*. Title.
[456] Ibid. p.12. Footnote.
[457] Ibid. p.13.
[458] Ibid. p.12.

movement militates against its synchronisation with rhythmic music.'[459] In other words, young infants have not yet developed the required motor control to synchronise their limbs movements with an offered stimulus. Notably, Merker et al. never state whether this is intentional or spontaneous response. Therefore, in Merker et al.'s study, 24 out of 25 infants showed no signs of SME or emergent SMS.

So, what about the one exception? When caregivers engaged with this 12 month old girl rhythmically, in the form of music, singing and dancing, she often displayed an ability to anticipate and match her actions with the next stimulus at a level of precision far greater than any event related response. Merker et al. explain:

> The […] 12-month-old girl shakes maracas in beat-for-beat synchrony with the drumming of her mother for 19 consecutive beats, starting after the mother had initiated drumming at a steady tempo. The girl had participated in twice-weekly ''baby rhythmicity'' sessions with her mother throughout her first year of life, and though we cannot be certain that her performance was not a chance occurrence, we mention it as a possible case of entrainment at 12 months of age.[460]

Out of the 25 infants, this girl was the only one to have had musical training. While, as Merker et al. correctly note, this may be a chance occurrence, it does suggest the possibility that practice and previous exposure to music played a contributing factor in her ability for SME.

Of course, we should be careful not to make hasty generalisations out of this. It would be misleading to infer a more generalised ability from just one example. Yet, when we combine this with the fact that tapping studies often show musically trained individuals have

[459] Merker et al. (2016). *On the Role and Origin of Isochrony in Human Rhythmic Entrainment*. p.12.
[460] Ibid. p.13.

a greater ability for SME at higher tempos than those who have not,[461] and that, as Cirelli et al. indicated, SS-EP in the brains of infants with musically trained parents are relatively higher,[462] it seems possible that the one girl in Merker et al.'s study had an increased ability for SME because of her previous musical exposure and training. Thus, more research is needed on whether an infant's ability for SME is something that can be improved with exposure and practice.

3.2.2 Breathing in Rhythms

Rhythmic respiration is more than a biomechanical process; it is also neurobiological. In their article, 'Breathing in Waves: Understanding Respiratory-brain Coupling as a Gradient of Predictive Oscillations,' Brændholt et al. explain that '[e]ach breath is initiated and coordinated by coupled oscillators periodically driving rhythmic respiration.'[463] Inhalation 'triggers mechanoreceptors connected to the olfactory bulb, thereby initiating […] neural oscillations closely coupled to the respiratory rhythm.'[464] Exhalation sends 'signals from the preBötzinger complex project to […] limbic and sensorimotor cortical areas.'[465] Therefore, the rhythmic exchange of gases with the environment also has a direct effect on the electrical activity of the brain, rhythmically evoking neural oscillations.

Elevated respiratory rates, such as when hyperventilating, decrease the carbon dioxide in the blood. The increased exhalation of carbon dioxide, combined with decreased oxygen inhalation, narrows blood vessels and limits the supply of oxygenated blood to the brain. This can cause symptoms such as dizziness, light headiness, nausea, heart palpitations, increased

[461] Repp (2005). *Sensorimotor Synchronization: A Review*. p.971 – 973.
[462] Ibid. p.8.
[463] Malthe Brændholt, Daniel S. Kluger, Somogy Varga, Detlef H. Heck, Joachim Gross, and Micah G. Allen (2023). Breathing in Waves: Understanding Respiratory-brain Coupling as a Gradient of Predictive Oscillations, *Neuroscience and Biobehavioral Reviews*. 152, 105262, p.2.
[464] Brændholt et al. (2023). *Breathing in Waves*. p.1.
[465] Ibid. p.2.

anxiety, and further hyperventilating.[466] Reduced respiratory rates, in contrast, decrease the carbon dioxide in the blood and brain. This can cause symptoms such as drowsiness, confusion, headaches and, in some extreme cases, even a loss of consciousness.[467] Therefore, the biomechanical and rhythmic exchange of gases with the environment also has a profound effect of the electrical activity and neural oscillations of the brain.

Brændholt et al. give a comprehensive review of the literature on respiratory and neural synchronisation in their paper, highlighting that 'an increasing body of research suggests that respiration directly influences rhythmic brain activity and sensory, affective, and cognitive functions beyond gas exchange physiology.'[468] Because the neurobiological mechanisms underlying so called 'respiratory modulated brain oscillations (RMBOs)'[469] are currently unknown, being only recently identified in mice,[470] Brændholt et al. created a computer model which synthesised existing findings and applied a form of so called Bayesian predictive coding.[471]

This methodology is a common one in computational neuroscience, as it allows researchers to infer neurological mechanisms from statistical data. By modelling the timing between breath and brain activity, Brændholt et al. were able to infer predictive neural

[466] Alexander Bennett (2021). Hyperventilation Syndrome, *Innovait*. 14(4), pp. 246 – 249.
[467] Juan F. Masa, Jean Louis Pépin, Jean Christian Borel, Babak Mokhlesi, Patrick B.Murphy, Maria Ángeles Sánchez-Quiroga (2019). Obesity Hypoventilation Syndrome, *European Respiratory Review*. 28(151), pp.1 – 14.
[468] Brændholt et al. (2023). *Breathing in Waves*. p.1.
[469] Ibid. p.1.
[470] Yevgenij Yanovsky, Mareva Ciatipis, Andreas Draguhn, Adriano B. L. Tort, and Jurij Brankačk (2014). Slow Oscillations in the Mouse Hippocampus Entrained by Nasal Respiration, *The Journal of Neuroscience*. 34(17), pp. 5949 – 5964; and Vivan Nguyen Chi, Carola Müller, Thérèse Wolfenstetter, Yevgenij Yanovsky, Andreas Draguhn, Adriano B. L. Tort, and Jurij Brankačk. (2016). Hippocampal Respiration-driven Rhythm Distinct From Theta Oscillations in Awake Mice, *The Journal of Neuroscience*. 36(1), pp.162 – 177.
[471] Bayesian predictive coding is a common approach in contemporary computational neuroscience. It combines Bayesian probability theory and statistics in order to infer the most probable explanations for observed neural data. See - Friedrich E. Lersch, Fabienne C. S. Frickmann, Richard D. Urman, Gabriel Burgermeister, Kaya Siercks, Markus M. Luedi, and Sven Straumann, (2023). Analgesia for the Bayesian Brain: How Predictive Coding Offers Insights into the Subjectivity of Pain, *Current Pain and Headache Reports*. 27(11), pp.631 – 638; Ladan Shams, and Ulrik Beierholm (2022). Bayesian Causal Inference: A Unifying Neuroscience Theory, *Neuroscience and Biobehavioral Reviews*. 137, pp.1 – 14; and Laurence Aitchison, and Máté Lengyel (2017). With or Without You: Predictive Coding and Bayesian Inference in the Brain, *Current Opinion in Neurobiology*. 46, pp.219 – 227.

oscillations in response to rhythmic respirations, concluding that their 'model suggests that respiratory rhythms are ubiquitous drivers of neural prediction, and that by better understanding this coupling […] might uncover new biomarkers in the domain of embodied and interoceptive computational psychiatry.'[472] In other words, Brændholt et al. where able to identify a steady state evoked response, where neural oscillations preceded the stimuli provided by breathing. In short, rhythmic respiration "pulls up" the frequency of neural oscillations. Brændholt et al.'s model thus suggests emergent synchronisation between rhythmic neural oscillations and respiratory rhythms.

Given that SME is something we can get better at with practice, and because, as Tort et al. put it, '[r]espiration-entrained brain rhythms are global but often overlooked,'[473] the question then arises: Can our capacity for respiration-entrained neural oscillations also be improved with practice? As of yet, no studies have conclusively answered this question. Nonetheless, the link between rhythmic respiration and brain is something many are aware of. It is something which many people practice to get better at, even if they do not think of it strictly in neuroscientific terms.

For example, breathing techniques, such as *lamaze*, are often taught during pregnancy in preparation for childbirth. It is well established that such breathing techniques, in the form of controlled rhythmic breathing, can decrease their feeling of pain and have a more general positive effect on both mother and infant.[474]

Similarly, in many Eastern traditions, meditative practices explicitly link breathing with mental states and processes, such as purported different states of consciousness and a

[472] Brændholt et al. (2023). *Breathing in Waves*. p.10.
[473] Adriano B. L. Tort, Jurij Brankačk, and Andreas Draguhn (2018). Respiration-entrained Brain Rhythms are Global but Often Overlooked, *Trends in Neurosciences*. 41(4), pp.186 – 197.
[474] Vanessa Leutenegger, Susanne Grylka-Baeschlin, Frank Wieber, Deirdre Daly, and Jessica Pehlke-Milde (2022). The Effectiveness of Skilled Breathing and Relaxation Techniques During Antenatal Education on Maternal and Neonatal Outcomes: A Systematic Review, *BMC Pregnancy and Childbirth*. 22(1), pp.1 – 19.

level of meta-awareness or detachment. In India, yogic practices, such as *Prāṇāyāma* प्राणायाम, have taught breathing techniques for at least the last 2000 years, only recently being recognised for their positive effects on the cardiovascular and nervous system.[475] More recently, the purported "physiological sigh" has begun to gain recognition as a way of both improving the efficiency of rest periods in athletic training and combating anxiety. Such studies starting to find that, as Vlemincx et al. explain, 'deep breath relieves and, in anxiety sensitive persons, reduces physiological tension.'[476]

Bridging the gap between the two, Grant et al. conducted an experiment which placed 39 participants (19 *Chan*/*Zen* 禪 Buddhist practitioners; 20 control) in an MRI, attaching a computer controlled thermal stimulus on their left calf.[477] At two second intervals, the temperature of the stimulus would incrementally increase, at which point participants were asked to rate their subjective feeling of pain on a scale of 0 (none) to 10 (extreme). Grant et al. observed two significant differences between the groups. The first difference was that 'meditators had thicker gray matter than control subjects in several regions known to be involved in pain processing.'[478] This was an expected finding, as the correlation between meditative practices and increased cortical thickness is well established.[479] The second noticeable difference between groups was 'that *Zen* practitioners were less sensitive to thermal pain than control subjects, requiring on average 50 °C versus 48 °C to report

[475] L Nivethitha, A Mooventhan, and NK Manjunath (2016). Effects of Various Prāṇāyāma on Cardiovascular and Autonomic Variables, *Ancient Science of Life*. 36(2), pp.72 – 77.
[476] Elke Vlemincx, Ilse Van Diest, and Omer Van den Bergh (2016). A Sigh of Relief or a Sigh to Relieve: The Psychological and Physiological Relief Effect of Deep Breaths. *Physiology & Behavior*. 165(0), p.127.
[477] Joshua A. Grant, Jérôme Courtemanche, Emma G. Duerden, Gary H. Duncan, and Pierre Rainville (2010). Cortical Thickness and Pain Sensitivity in Zen Meditators, *Emotion*. 10(1), pp.43 – 53.
[478] Grant et al. (2010). *Cortical Thickness and Pain Sensitivity in Zen Meditators*. p.46.
[479] Britta K. Hölzel, James Carmody, Mark Vangel, Christina Congleton, Sita M. Yerramsetti, Tim Gard, and Sara W. Lazar (2011). Mindfulness Practice Leads to Increases in Regional Brain Gray Matter Density, *Psychiatry Research*. 191(1), pp.36 – 43; and Sara W. Lazar, Catherine E. Kerr, Rachel H. Wasserman, Jeremy R. Gray, Douglas N. Greve, Michael T. Treadway, Metta McGarvey, Brian T. Quinn, Jeffery A. Dusek, Herbert Benson, Scott L. Rauch, Christopher I. Moore, and Bruce Fischl (2005). Meditation Experience is Associated with Increased Cortical Thickness, *Neuroreport*. 16, pp.1893 – 1897.

moderate pain.'[480] Revealingly, amongst *Zen* practitioners, Grant et al. found that sensitivity to thermal pain was relative to their experience with meditative practices.[481]

While the *Zen* practitioners increased cortical thickness and decreased pain sensitivity may also be due to the exposure to painful sitting postures typically associated with *zazen* 坐禅 (seated meditation), such as sitting in the painful *kekkahuza* 結跏趺坐 (full lotus) position, such pains are often treated with equanimity through slow and controlled rhythmic breathing. Thus, *Zen* practitioners have long known something neuroscientists are just now investigating: rhythmic breathing patterns have a direct effect on the brain. So, is SME between breath and brain something we can get better at with practice? The *Zen* practitioner would likely say yes.

To test this very thing, Hölzel et al. created a longitudinal study where 35 participants (two groups, 18 experimental and 17 control) were chosen to take part in a so called Mindfulness-Based Stress Reduction (MBSR) programme.[482] MBSR, first developed in the 1970s by Jon Kabat-Zinn,[483] offers a secular approach to mindfulness and meditative practice, borrowing loosely from many different Eastern traditions and omitting any explicit religious doctrines or beliefs. Hölzel et al.'s iteration of MBSR is given as follows:

> eight weekly group meetings lasting 2.5 h each, plus 1 full day (6.5 h) during week 6 of the course. Formal mindfulness training exercises aim at developing the capacity for mindfulness […] and include a body scan, mindful yoga, and sitting meditation. […] The mindful yoga typically contains gentle stretching exercises and slow movements that are often coordinated with the breath, with emphasis placed on bringing full awareness to the moment-to-moment experience […]. Sitting meditation

[480] Grant et al. (2010). *Cortical Thickness and Pain Sensitivity*. p.47.
[481] Ibid. p.46.
[482] Hölzel et al. (2011). *Mindfulness Practice Leads to Increases in Regional Brain Gray Matter*. pp.36 – 43.
[483] Jon Kabat-Zinn (2013). *Full Catastrophe Living: How to Cope With Stress, Pain and Illness Using Mindfulness Meditation*. London; Piatkus.

> practices typically begin with awareness of the sensations of breathing, then evolve to include awareness of different modalities.[484]

Putting aside the fact that the MBSR may be somewhat chauvinistic, cherry-picking from the beliefs and practices of religious traditions, this allowed Hölzel et al. to measure participants' ability to improve their capacity for rhythmic breathing patterns that can directly affect the brain.

Two weeks before and after this programme, participants were placed in a MRI, with researchers finding significant 'changes in brain gray matter concentration following an 8-week [MBSR] course compared with a control group.'[485] Additionally, participants were asked to fill out a questionnaire, from which the MBSR group reported an improved ability for mindfulness and equanimity in their daily lives. These findings aligned with those of the MRI, as significant improvements in mindfulness, including the associated exercises, were measured in the MBSR group. That is to say, they got better with practice.

Of course, improving mindfulness, along with the associated breathing techniques, does not necessarily demonstrate either synchronisation or entrainment. It also does not show that the ability for SME can be enhanced with practice. However, what is does show is that researchers are well justified in looking for SME between rhythmic respiration and neural oscillations. It also shows that further research is necessary, and that, as will be shown in the next section, we are rapidly approaching the limits of modern neuroscience.

3.3 Interpersonal Studies

Like tapping and movement studies, interpersonal studies are interested in how SME can give rise to a period of emergent SMS, although they typically have little to say in regards to why. This is because the common consensus is that, as Repp explains,

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[484] Hölzel et al. (2011). *Mindfulness Practice Leads to Increases in Regional Brain Gray Matter*. p.37.
[485] Ibid. p.40.

> SMS is normally an intentional activity and, by definition, an overt one, because it involves movement. […] Although movement in synchrony with a rhythmic beat may occur unintentionally, it can easily be suppressed when attention is paid to it, as is shown by audiences sitting still during a concert performance.[486]

In other words, whether tapping a finger to a beat, dancing to music, or even breathing, intention has a significant role to play. Movement and intention are intrinsically linked. At the very least, it *feels* that way.

Interpersonal studies typically look at how 'the brain synchronizes not only to environmental stimuli but also to sensory or semantic cues derived from another agent in a joint action or communication,'[487] while often completely ignoring the role of intention. While physicalist explanations *may* very well be possible for intention in SME, this is far beyond the purview of contemporary neuroscience and highly speculative. To gain an appreciation for the role of intention, let us look at three individual studies which investigate SME in dancing, rocking chairs, and playing music.

3.3.1 Dancing Studies

In 'The Impact of the Bass Drum on Human Dance Movement,'[488] Van Dyck et al. created an interpersonal study to measure a group of dancers' ability to entrain their movements with the sound of a rhythmic beat. Van Dyck et al. were specifically interested in how different sound pressures, or loudness, contribute to the ability for SME. The motivation for this behavioural study was, as Van Dyck et al. explain, 'a phenomenon often observed in dance clubs where DJs boost the volume of the bass drum in order to motivate the audience

[486] Repp (2005). *Sensorimotor Synchronization: A Review*. p.970.
[487] Repp, and Su (2013). *Sensorimotor Synchronization: A Review of Recent Research.* p.440.
[488] Van Dyck et al. (2013). *The Impact of the Bass Drum on Human Dance Movement*. Title.

to move.'[489] Van Dyck et al. thus aimed to study something music lovers already know; increases in volume can lead to increased movements.

In their experiment, Van Dyck et al. recruited 100 participants, the majority having some musical training and reporting that they enjoyed dancing.[490] Randomly divided into groups of five, each participant was fitted with motion sensors attached to their head and hips and instructed to dance however they wished when entering an experimental room. In this experimental room, Van Dyck et al. attempted to create a 'club-style'[491] setting for participants. This was a room enclosed with black curtains, fitted with sound-sensitive lights, as well as hidden loudspeakers. Six novel songs, all electronic dance music with a consistent tempo of 128 BPM, were played over a 30 minute period.

Notably, '[e]ach of the six songs consisted of three loops of a 16-bar core-motive […], featuring three different sound pressure levels of the bass drum (bass drum levels, BDLs).'[492] Between each song, the bass drum was played in isolation for 15 seconds, thus providing Van Dyck et al. with a point of reference for their analysis. Van Dyck et al. expected to find 'that an increase in the loudness of the bass drum could enhance tempo entrainment and activity.'[493] In other words, they predicted that higher volumes would "pull up" the frequency of dancing in much the same way that higher acoustic frequencies do.

Van Dyck et al. made three important discoveries, one of which came as a surprise. The first was that higher BDLs did, as expected, enhance the ability for SME. Van Dyck et al. explain 'that participants did indeed embody the dynamic level of the bass drum. Analysis revealed that an intensification of the sound pressure level of the bass drum led to an increase

[489] Van Dyck et al. (2013). *The Impact of the Bass Drum on Human Dance Movement*. p.356.
[490] Ibid. p.351.
[491] Ibid. p.357.
[492] Ibid. p.351.
[493] Ibid. p.356.

in activity count.'[494] In other words, the lounder the sound, the more closely participants movements became synchronised with it. While an important finding, insofar as it suggests that the ability for a rhythmic stimuli to "pull up" may be linked to sound pressure as well as tempo, this came as no surprise to Van Dyck et al.

The second observation was that the movements of '[p]articipants of the same group correlated stronger with each other than with participants of other groups.'[495] Put another way, the dancing of each individual group was synchronised, with individual dancers often matching the movements of each other. Of course, synchronisation is not necessarily entrainment. Deliberate or intentional synchronisation is a large part of what dancing with other people entails. It is unclear whether the emergent SMS in Van Dyck et al.'s study was spontaneous, intentional, or some combination of the two. There are many other contributing factors which can give rise to synchronisation when dancing in a group, most of which fall well beyond the scope of Van Dyck et al.'s study, as well as contemporary neuroscience more generally.

This was particularly exemplified by the third finding, where 'a general effect was uncovered as female participants moved more actively than their male counterparts.'[496] Once again, there are a myriad of possible reasons for this disparity between male and female participants, many of which Van Dyck et al. are quite happy to speculate about. Evolutionary biology, sexual selection, social norms, and personal attitudes towards dancing, all could be possible reasons why female participants tended, as well as intended, to dance more actively than male.

Evolutionary biologists Ravignani and Cook offer a potential answer: 'While not sufficient for dance, modes of auditory-motor timing, such as synchronization and

[494] Van Dyck et al. (2013). *The Impact of the Bass Drum on Human Dance Movement*. p.356.
[495] Ibid. p.357.
[496] Ibid. p.357.

entrainment, are experimentally tractable constructs that may be analyzed [i]n an effort to assess the evolutionary precursors to entrainment and social features of human dance.'[497] Here, Ravignani and Cook correctly point out that while interpersonal studies investigating SME between rhythmic movements and stimuli are important in understanding the evolution of dance, they are insufficient to fully explain the interpersonal and social aspects. Movement studies can help us understand *how* we synchronise our movement with music and each other, but not *why*. Nor can they explain how, as Noë previously gave, '[w]hen two people dance, their movements and actions and thoughts and perceptions are entrained by the larger organization, the dancing itself.'[498] Thus, interpersonal studies which investigate dancing as a group, fail to fully account for the role of intention, as well as a myriad of other social and cultural factors.

3.3.2 "Rocking" studies

Walter et al., in 'Brains Swinging in Concert: Cortical Phase Synchronization While Playing Guitar,'[499] created a study which 'investigated whether the phase synchronization of brain oscillations within and between the brains is enhanced in pairs of guitarists during the preparatory period of metronome tempo setting and while playing a melody together.'[500] Walter et al. aimed to measure the synchronisation in and between two guitarists' brain activity when listening to a metronome and when playing music together.

This study selected 16 guitarists, eight pairs, with an average of 5 years of experience playing music. Over 60 separate trials, Walter et al. used an EEG to measure the electrical activity in participants' brains while they listened to a metronome, followed immediately by playing a melody especially composed for the experiment. Walter et al. explain that, '[a]t the

[497] Andrea Ravignani and Peter F Cook (2016). The Evolutionary Biology of Dance Without Frills, *Current Biology*. 26(19), R878, p.1.
[498] Noë (2015). *Strange Tools*. p.12
[499] Walter et al. (2009). *Brains Swinging in Concert*. pp.1 - 12.
[500] Ibid. p.2.

beginning of each trial, at least four metronome beats were played through a loudspeaker to both guitarists of each pair. […]. Thereafter, the lead guitarist (A) gave a sign to start, and then the duo started to play the melody together in unison.'[501] The guitarists were instructed not to move until the metronome sequence had finished, at which point they were to start playing.

Walter et al. first measured the neural '[s]ynchronization during the preparatory period,'[502] when participants were listening to the metronome with no corresponding movement, before measuring neural '[s]ynchronization after play onset.'[503] Combining the two, Walter et al.'s measured:

> synchronization both within and between the brains was considerably reduced relative to the first 2s after play onset […]. These synchronization patterns were also related to the onset of the starting note while playing. Interestingly, in the time window between the 8th and 11th seconds, that is, after the end of play, between-brain synchronization disappeared completely. [504]

What Walter et al. are saying here is that, when listening to a metronome in the preparatory period, the synchronisation between the guitarists' brains was at its strongest. After playing commenced, this synchronisation continued at a reduced rate, briefly becoming synchronised to correspond with specific notes, and completely disappearing at the end of the piece.

In the preparatory period, the measured synchronisation in participants' brains was a SS-EP, in the sense that it was a period of emergent synchronisation where the measured neural oscillations preceded the beat. During the joint performance, when both guitars were playing the same melody, the SS-EP was less consistent, with the synchronisation decreasing

[501] Walter et al. (2009). *Brains Swinging in Concert*. pp.2 – 3.
[502] Ibid. p.3.
[503] Ibid. p.5.
[504] Ibid. p.5.

significantly. From their study, Walter et al. assert 'that interpersonally coordinated actions are preceded and accompanied by between-brain oscillatory couplings. Presumably, these couplings reflect similarities in the temporal properties of the individuals' percepts and actions.'[505] This is problematic because it, once again, conflates synchronisation with entrainment.

Walter et al.'s findings do not show a coupling between brains. While there very well may have been, it is just as possible that the observed synchronisation is just that, synchronisation. Given that both guitarists were entrained with the same metronome in the preparatory period, and thus individually synchronised with it, it is possible that this synchronisation was sustained during their joint performance. This would also explain why there was a decreased synchronisation as they continued to play, as the synchronisation measured between the two brains was secondary to the SS-EP measured within. To put it another way, the frequency of neural oscillations in each individual brain was pulled up to match the frequency of the metronome, giving rise to a period of emergent synchronisation. This emergent synchronisation just so happened to coincide with a similar process occurring in their partner's brain. Thus, both brains became entrained with the rhythmic stimuli of the metronome, not necessarily with each other.

Secondly, and Walter et al. allude to this fact,[506] the movements of guitarists performing together involves intention, in the sense that they intended that they play the melody in a harmony. This too could give rise to synchronisation without SME. Walter et al.'s study only shows SMS when two guitarists are "rocking" together. We will look at this in more detail in Chapter 4, Section 3.1, as it highlights an important distinction between

[505] Walter et al. (2009). *Brains Swinging in Concert*. p.10.
[506] Ibid. pp.5 – 7.

spontaneous entrainment, intentional synchronisation, and intentional spontaneous entrainment.

3.3.3 Rocking Studies

When researchers ask participants to find and keep a beat, this is not merely a spontaneous sensorineural and sensorimotor response, but often an intentional activity. The participant intends that they tap their finger, or intends that they move with another, and so on. In 'Spontaneous Vs Intentional Entrainment to a Musical Beat,'[507] Demos et al. created a study which aimed to investigate the role of intention in SME. Over fifteen trials, 45 seconds each, thirty one participants sat in a rocking chair in front of a screen, being 'told that the purpose of the experiment was to test interaction of memory and movement.'[508] Each participant was then asked to perform a cover task, memorising flashing words on the screen, while rocking in the chair with the sound of music being played. The methodology of this experiment is particularly revealing and, as such, requires extensive citation:

> Two *baseline trials* at the beginning and two more at the end were conducted without music in order to provide a baseline measurement of each participant's natural rocking tempo. Eleven *music trials*, during which a steady drum/cymbal beat sounded in the background, assessed the affect of music on participants' rocking tempo. […] For the music trials, participants were either told to rock at a comfortable pace, i.e., with no instruction to rock with the music (spontaneous condition […]) or to rock with the music as best they could (intentional condition […]).[509]

Here, Demos et al. aimed to measure any emergent synchronisation between participants' natural rocking tempo, their natural frequency, and the rhythmic tempo of the music, as well

[507] Alexander P. Demos, Roger Chaffin, and Kerry L. Marsh (2010). Spontaneous Vs Intentional Entrainment to a Musical Beat; Conference: Proceedings of the 11th International Society for Music Perception and Cognition, *ResearchGate*. pp.1 – 4.
[508] Demos et al. (2010). *Spontaneous Vs Intentional Entrainment*. p.1.
[509] Ibid. pp.1 – 2.

as any differences between spontaneous and intentional SME. This is a significant departure from all of the previous studies, as spontaneous SME has been the primary focus of all. Demos et al. discovered that '[p]articipants in the spontaneous and intentional conditions were affected in similar ways by the music; however, participants in the intentional condition exhibited more entrainment with the music […] above chance levels.'[510] These findings suggest that tapping and movement studies are too simplistic, as they do not explicitly account for role of intention, nor do they, as Demos et al. conclude, 'reveal more of the more complex behaviors that people naturally exhibit when moving to music.'[511] We will explore this in Chapter 4, Section 3, as it highlights an important distinction between spontaneous entrainment, intentional synchronisation, and intentional spontaneous entrainment.

3.4 Summary and Context

In summary, SME can be understood as an ORDER system. The SMS, like the SNS and brain, is an open energy system, as is the world. When moving, the primary motor cortex of the brain sends electrical signals, via motor neurons, to effector cells in the muscles and tendons. The subsequent actions then transfer energy directly to the perceived world. Combined with the neural and sensorineural system, the SMS transfers and absorbs energy. This entails movement in a perceived world that includes other people.

The SMS is also a resonating system. Humans both act in and get acted upon by the perceived world, including other people. Perceived natural frequencies, such as an acoustic or visual rhythm, can energetically "pull up" the natural frequency of the brain, SNS, and SMS, such as when tapping finger or dancing to a perceived beat. This downward resonance is also applicable when perceiving the rhythms offered by other people. However, there *may* also be upward resonance when people are acting together. While this has yet to be conclusively

[510] Demos et al. (2010). *Spontaneous Vs Intentional Entrainment*. p.4.
[511] Ibid. p.4.

identified by researchers, the neurobiology of all humans has a similar natural frequency, falling within the natural variation for our species. When we act, we often get acted upon. When we see, we are often seen. Accordingly, perceived natural frequencies may resonate with a perceiver, thereby evoking either upward or downward resonance.

The SMS is a dissipating system, subject to the laws of thermodynamics and entropy as the perceived world. All couplings between open systems must end, as must any upward or downward resonance between. Our SMS is part of a wider energy system that includes the SNS, brain, body, world, and other people. The last of these, other people, can contribute to the rapid dissipation of energy, whether spontaneously or intentionally.

The SMS is also an emergent system, in the sense that energy provided by the perceived world, including other people, can "pull up" or "pull down" the natural frequency of movements. This downward or upward resonance can initiate and sustain a period of emergent synchronisation between actions and the perceived world. The SMS and brain become increasingly synchronised with the perceived world for as long as they remain coupled.

The SMS is also a rhythmic system, as is much of the perceived world. Many of our actions, such as tapping a finger, dancing, and even breathing, display a recurring, periodic, and oscillating pattern. The rhythmicity of movement can be modified by perceived rhythmic stimuli, such as an audible or acoustic rhythm. This occurs by way of a steady-state and recurring transfer of energy between our movements and the perceived rhythms of our environment, including other people.

SME shows that the emergent synchronisation between humans and their environments, including their social surroundings, is something that we can all do and, importantly, something that we can get better at with practice and exposure. The literature on

SME also reiterates the importance of distinguishing between synchronisation and entrainment, as exemplified by the fact that many interpersonal studies assert meaningful connections from mere synchronisation. Finally, SME highlights the role of intention, if any, has been largely omitted from the scientific literature.

In context, SME can be understood as an instantiation of Nishida and Noë's world of action and organisation. It exemplifies how ORDER systems are considerably more complex in the sociohistorical realm that those found in the material and biological. While it provides a concrete mechanism for understanding how the world of action and organisation applies to our brains, SNS, and SMS and a perceived environment, SME also highlights the vast complexity of the sociohistorical realm, as interpersonal and intersubjective activities in the sociohistorical realm also involve intention. Like *kōiteki chokkan*, where '[w]hat we do shapes what we are, shapes the world that in turn shapes us,'[512] our existence as part of the sociohistorical world sees us spontaneously and intentionally shaped by a world that both includes and transcends the intentions of other people. Therefore, while SNE provides a concrete mechanism for understanding how the world of action and organisation applies to our brains and perceived environments, it also highlights, once again, how entrainment in the sociohistorical realm is far more complex than it is in the material and biological.

Section 4: Conclusion

In conclusion, neuroecological entrainment reveals the interconnectedness and ambiguity between humans and their surroundings, ranging from relatively simple auditory or visual stimuli to complex social interactions with other people. It illustrates how periods of emergent synchronisation can be initiated and sustained by the rhythmic transfer of energy between humans and their perceived environments, including other humans. This is a basic fact about our ecological existence, if not the very reason for it. At the very least,

[512] Maraldo (2017). *Japanese Philosophy in the Making*. p.199.

neuroecological entrainment is something we humans can exploit; artists, as we will see, in particular.

However, studies looking at neuroecological entrainment are rapidly approaching the limits of contemporary science. The previous studies looking at neural entrainment, SNE, and SME have all, for the most part, investigated *how* entrainment gives rise to a period of emergent synchronisation, offering little in regards to *why*. Trying to understand entrainment by only studying instances of spontaneous entrainment between our perceived environment and neurobiological systems is an improvised account. It fails to account for the role of intention, if any.

Therefore, in the next chapter, a response will be given from Nishida and Noë's point of view. While entrainment does provide an empirical explanation for their world of action and organisation, it is evidently constrained by the limitations of contemporary science. To account for this, Nishida and Noë can help contemporary science return to its philosophical foundations and reassess some of its ontological assumptions. Both authors will have much to say on this topic, given that they will be shown to reject the patina of positivism often found in contemporary science. Therefore, Nishida and Noë are well situated to engage with science in the next chapter, offering a critical perspective on world of action, organisation, and entrainment, as well as the role of art within.

Chapter 4: The Entanglement of Art, Life, and Entrainment

Improvisational violinist Stephen Nachmanovitch (1950 – present) has a novel pedagogical approach to teaching improvisation to his students. In a 2005 lecture for the *College Band Directors National Association* in New York, Nachmanovitch describes how he intentionally uses gibberish as a tool for teaching musicians to spontaneously harmonise.[513] In groups of 20, students are asked to form a circle and individually take turns making nonsensical sounds while gesturing to another participant, who must then spontaneously and without interruption do the same. This error-free approach frees students from the fear of making mistakes, while allowing them to engage in spontaneous and non-deliberative vocalisations together.

Nachmanovitch observes: '[w]hat comes out in the first few seconds seems random. After the briefest time it evolves into patterns that seem far from random, patterns that already show some structure, interest, musicality. […] Minute by minute, as the procedure of improvisation evolves, you see it connect more and more into itself so that it becomes something identifiable.'[514] At this point, Nachmanovitch asks students to transition to their instruments, giving rise to improvised, collaborative, organised, and synchronised creations. Nachmanovitch's pedagogical approach demonstrates the interplay between spontaneous entrainment, intentional synchronisation, and intentional spontaneous entrainment, showing how emergent organised activities and ORDER systems resonate within the material, biological, and sociohistorical world. This also highlights how artists, often tacitly aware of this, can intentionally use spontaneous entrainment as a tool within their practices and creations.

[513] Stephen Nachmanovitch (2005) *On Teaching Improvisation*, 24th February 2005, New York, College Band Directors National Association.
[514] Nachmanovitch (2005) *On Teaching Improvisation*.

To explore this, section one begins by addressing Nishida's explicit rejection of positivist ontologies, which he calls 'object logic'[515] or the 'logic of objects,'[516] and which are implicit in many of the scientific studies on entrainment discussed previously, many of which were shown to omit the role of intention. Nishida's underdeveloped philosophy of science, bolstered by Noë's *aesthetic paradigm*, addresses this, showing how science is embedded in culture and that subjectivity is not antithetical to science.

Section two explains Noë's concept of "style" as the visible and intelligible expression of what we are within the aesthetic paradigm. For Noë, style is an unfolding aesthetic phenomenon that cannot be reduced to mere material and biological processes, further suggesting that ORDER and style are entangled, resonating with each other and the sociohistorical world in which both are embedded.

Section three argues that entrainment is a tool that artists can intentionally use to reshape the organised activities that shape and define our style. It distinguishes between spontaneous entrainment, intentional synchronisation, and intentional spontaneous entrainment within the sociohistorical world, showing how Nishida and Noë's combined world of action and organisation evokes spontaneous, intuitive, and non-deliberative actions.

The core thesis of this chapter, and of this dissertation, is that art, life, and entrainment are entangled, and that this entanglement makes us what we are. By supporting Nishida's philosophy of science with Noë's *aesthetic paradigm*, it is argued that, rather than being a mere mechanical process or metaphor, entrainment is a powerful tool within the world of action and organisation, allowing us to intentionally shape, organise, and redefine our style. In short, the entanglement of art, life, and entrainment makes us what we are.

[515] Nishida (1987). *Last Writings.* p.54.
[516] Ibid. p.49.

Section 1: Positivist Ontologies and the Aesthetic Paradigm

In the opening pages of *Philosophy of Science and The Kyoto School*, Dean Anthony Brink makes it clear: 'One point that needs to be made early on is that modern physics in Japan is continuous with modern physics anywhere.'[517] In many ways, Japan is at the forefront of modern physics, with physicists such as Jun Ishiwara 石原 純 (1881 – 1947), Hideki Yukawa 湯川 秀樹 (1907 – 1981), Isamu Akasaki 赤﨑 勇 (1929 – 2021), and Syukuro Manabe 真鍋 淑郎 (1931 – present) all gaining renown internationally. However, as Brink also notes, '[w]hat is specific to Japan are the cultures within which science is shaped and […] used to support their own systematic explorations of metaphysical issues in phenomenology, ontology and epistemology,'[518] as is it true for sciences developed in all cultures.

For Nishida, contemporary science has a patina of positivism that must be addressed, specifically pertaining to the explanatory power of science, as he explicitly states:

> I disagree altogether with the epistemological position that takes its point of departure from the logic of objects. I hold that thinking takes place within the structure of an interexpressive relation.[519]

Noë has a similar issue with positivism, explaining that:

> Nothing more perfectly illustrates the deforming influence of the prestige attached to the model of positive science than its ability to lead us to believe that we are dispassionate observers building theories on the basis of evidence, when in fact we are

[517] Brink (2021). *Philosophy of Science and The Kyoto School*. p.6.
[518] Ibid. p.6.
[519] Nishida (1987). *Last Writings.* p.49.

> participants acting from activity-internal evaluations and implicit mastery of the relevant cultural norms. [520]

These two quotes are targeted at positivism, and how this doctrine prioritises observation, logical analysis, and objectivity in science. Although other scientific paradigms exist, such as *postpositivism* and *antipositivism*, which Nishida and Noë sometimes align with, both authors critique the foundations of studies like those on entrainment in the previous chapters, as they are often rooted in positivist assumptions, even if only implicitly. Thus, before further discussing the significance of entrainment in Nishida and Noë's philosophy, we must first explore the positivist paradigm to which they are responding, as well as their comparable understanding of science.

1.1 Positivist Paradigms

While positivist ontologies and paradigms can be traced back at least as far as Aristotle, it needs to be first acknowledged that Nishida mistakenly equates the logic of contemporary science with Aristotelian logic. While Nishida's view does have some merit, in the sense that science and Western logic typically prioritises "being" and "presence," as well as dismissing the possibility of logical and ontological contradictions, it is a mistake to equate the logic of, say, Bertrand Russell, with that of Aristotle. While there are important similarities to be found, positivism is a distinct philosophical tradition that does not directly derive from Aristotle. This error is not unique to Nishida; similar oversimplifications are often found in cross-cultural philosophy when thinkers work at a level of generality that overlooks the evolving complexities of philosophical traditions. Just as it would be reductive to categorise "negative ontologies" as solely East-Asian, or to assume any singular or unified position, it is an oversimplification to conflate contemporary positivist ontologies and paradigms entirely with Aristotelian logic. Thus, to address Nishida's tendency to equate

[520] Noë (2023). *The Entanglement.* p.91.

contemporary scientific logic with Aristotelian logic, and to approach his perspective charitably, it is necessary to examine *classical positivism* and *neopositivism*—both of which, as we shall see, are critiqued by Nishida's logic and ontology.

1.1.1 Classical Positivism

Auguste Comte (1798 – 1857), founder of classical positivism, offers 'a theory of knowledge according to which the only kind of sound knowledge available to human kind is that of science grounded in observation.'[521] First articulated in *The Course in Positive Philosophy*,[522] and later in *A General View of Positivism*,[523] Comte explains his brand of classical positivism according to the asserted development of society through three stages: 1. theological Stage, 2. metaphysical stage, and 3. positivist stage.[524]

For Comte, the positivist stage is the evolution or natural progression from the theological and metaphysical stages. This is when, at some time in the future, reason and science preside over society. When society moves away from theological and metaphysical explanations about the world, prioritising empirical and observable explanations for natural and social phenomenon. Comte explains:

> The scientific spirit is radically distinguished from the theological and metaphysical by the steady subordination of the imagination to observation; and though the positive philosophy offers the vastest and richest field to human imagination, it restricts it to discovering and perfecting the co-ordination of observed facts.[525]

[521] Auguste Comte (1891). Cited in – M. J. Vinod, and Meena Deshpande (2013). *Contemporary Political Theory*. Delhi; PHI Learning Private Limited. p.3.
[522] Auguste Comte, and Harriet Martineau, ed. (1853;2009). *The Positive Philosophy of Auguste Comte*. Cambridge University Press.
[523] Auguste Comte, and J. H. Bridges, trans. (1865; 2015). *A General View of Positivism*. Cambridge; Cambridge University Press.
[524] Comte (2009). *The Positive Philosophy of Auguste Comte*. Chapter 1.
[525] Ibid. pp.68 -69.

Comte is saying here that positivist philosophy allows for abstract principles and philosophies only to the extent that they correspond with the observable world. This, Comte believes, leaves ample room for human imagination and speculation in science, yet confines both to the task of revealing observed facts about the world. Therefore, as Comte understands it, science is in the business of describing reality, and knowledge thereof can only be achieved by way of observation.

In this way, for Comte, science can provide order and progress. It provides order by fostering a dispassionate and empirical analysis of the world, along with evidence about the natural and social phenomena grounded in observation. Science also provides progress, cultivating and creating new socio-political and scientific frameworks. Thus, for Comte, the positivist stage is when society recognises the explanatory power of science, allowing its methodologies and emphasis on observation to reign supreme.

Because of this, Comte has little to say about consciousness, perception, mental states and process, or, more generally, the inner workings of the mind. Nor would Comte have much to say about the unobservable aspects of reality studied in contemporary science, such as atoms, quantum particles, fundamental forces, or, more generally, the underlying structures of physical matter. Consequently, for classical positivists like Comte, the unobservable workings of our world fall outside the framework of scientific inquiry.

It needs to be mentioned that classical positivism was more of a general tradition than a strict doctrine. While Comte did lay much of the groundwork, thinkers such as Ernst Mach (1838 – 1916), Jules Henri Poincaré (1854 – 1912), and Pierre Duhem (1861 – 1916) would all offer subtle variations. Nevertheless, the general consensus is that knowledge about reality can *only* be acquired by way of observation, as reality is a realm of ontologically distinct and mind independent objects.

1.1.2 Neopositivism

Neopositivism, also known as logical positivism or logical empiricism, is a 20th century doctrine that builds upon the works of classic positivists like Comte, as well as, more generally, positivist ontologies that can be dated back to Aristotle. This doctrine also asserts that knowledge about reality can be gained by observation, while adding an additional means of enquiry: logical analysis.

This is the purported *scientific world-conception* of the Vienna Circle, a group of philosophers who met regularly in the University of Vienna between 1924 and 1936. While there was the expected amount of disagreement among members, Victor Kraft explains that '[t]here was one common tenet: […] philosophy ought to be scientific. The rigorous requirements of scientific thinking were postulated for philosophy. Unambiguous clarity, logical rigor and cogent argument are as indispensable to philosophy as to the other sciences.'[526] Like Comte before them, members of the Vienna Circle rejected dogmatic theological and metaphysical claims that could not be verified by observation.

However, the Vienna Circle also recognised that observation alone is insufficient. This is explicitly stated in their 1929 pamphlet:

> We have characterised the *scientific world-conception* essentially by *two features*. *First* it is *empiricist* and *positivist*: there is knowledge only from experience, which rests on what is immediately given. […] *Second*, the scientific world-conception is marked by application of a certain method, namely *logical analysis*.[527]

[526] Victor Kraft (2015). *The Vienna Circle: The Origins of Neo-positivism (1st ed.).* New York; Philosophical Library. Part Two, p.14.
[527] Vienna Circle (1929). The Scientific Conception of the World: The Vienna Circle, In – Otto Neurath, Marie Neurath, and Robert S. Cohen (1973). *Empiricism and Sociology: Vienna Circle Collection*. Dordrecht, Holland; D. Reidel Publishing Company. Chapter 9, p.309.

The first feature aligns with classical positivism, stating that knowledge about reality can be verified through observation. The second feature, however, recognises that there are aspects of reality that are not directly observable, allowing for *a priori* justifications in mathematics and formal logic, to name but a few.

For example, Albert Einstein (1879 – 1955), despite not being a member, was considered one of the Vienna Circle's three '[l]*eading representatives of the scientific world-conception*,'[528] alongside philosopher and logician Bertrand Russell (1872 – 1970). When asked about classical positivism, Einstein famously said:

> I am not a positivist. Positivism states that what cannot be observed does not exist. This conception is scientifically indefensible, for it is impossible to make valid affirmations of what people "can" or "cannot" observe. One would have to say "only what we observe exists," which is obviously false.[529]

While this is not the most charitable interpretation of classical positivism, forty years prior to this interview, in 1905, Einstein published four papers, one on special relativity, one on his novel idea of quanta, and one on the equivalence of energy and mass. In the same year, Einstein published his fourth paper providing convincing evidence for, arguably proving, the existence of atoms.[530] In the introduction to this paper, Einstein explains:

> If it is really possible to observe the motion to be discussed here, along with the laws it is expected to obey, then classical thermodynamics can no longer be viewed as

[528] Vienna Circle (1929). *The Scientific Conception of the World*. p.318.
[529] From Albert Einstein's interview with Alfred Stern (1945), cited in – Alice Calaprice (2019). *The Ultimate Quotable Einstein*. Princeton; Princeton University Press. p.395.
[530] Albert Einstein (1905). On the Motion of Small Particles Suspended in a Stationary Liquid, as Required by the Molecular Kinetic Theory of Heat, *Annalen der Physik*. 17, pp.549 – 560.

> strictly valid even for microscopically distinguishable spaces, and an exact determination of the real size of atoms becomes possible.[531]

Einstein states here that observation is insufficient for investigating the atomic and subatomic aspects of reality.

In order to account for the unobservable, the Vienna Circle aligned with the scientific consensus of the time, deeming logical analysis, specifically formal logic, as an appropriate way to gain knowledge about the aspects of reality that are unobservable to the eye. This emphasis on logic is clearly exemplified in Einstein's previously mentioned paper, wherein he provides compelling evidence for the existence of atomic particles with a number of logical proofs.

Notably, the Vienna Circle's recognition of logical analysis was not a novel or even controversial methodology, as many of Einstein's peers, such as Erwin Schrödinger (1887 – 1961), Niels Bohr (1885 – 1962), and Werner Heisenberg (1901 – 1976), had all begun to utilise the methodology of formal logic to investigate and understand the unobservable aspects of reality.

Accordingly, the Vienna Circle were strong advocates for the growing consensus of the time. This is why they placed philosopher and logician Bertrand Russell, alongside Einstein as one of their '[l]*eading representatives*.'[532] Therefore, neopositivism, as exemplified by the Vienna Circle's '*scientific world-conception,*'[533] is a doctrine where knowledge about reality must be verified by observation or logical analysis.

[531] Einstein (1905). *On the Motion of Small Particles Suspended in a Stationary Liquid*. p.549..
[532] Vienna Circle (1929). *The Scientific Conception of the World*. p.318.
[533] Ibid. p.309.

1.1.3 Three Positivist Assumptions

In science, classical positivists and neopositivists (hereafter positivists) often make three assumptions, implicitly shaping the formulation of scientific research questions, methodologies, interpretations of data, and so on.

The first positivist assumption is ontological, and, as Nishida identifies, can be dated as far back as Aristotle. Within this paradigm, reality is understood as a realm of ontologically distinct "things" or "substances" causally interacting. This is commonly referred to as a "substance ontology," being a realm of circumscribed and limited "objects" that exist on the macro or micro scale. It is an objective and mind independent realm, existing entirely separate from subjectivity.

This substance ontology is what many in East-Asian philosophical traditions, notably China and Japan, would call the realm of *you* 有, or of being, presence, existence, and so on. Accordingly, the complementary and corresponding realm of *wu* 無, or of nonbeing, nonpresense, and nonexistence is typically omitted by positivists. While there are important and significant differences within and between Asian philosophical traditions, the relevant point here is that these traditions typically have a more expanded understanding of reality than positivists, finding *wu* to be equally as important as *you*.

While Nishida does recognise this positivist assumption, he is explicitly interested in critically engaging with the logical and ontological structure it entails, as noted by Dilworth and Viglielmo who explain that Nishida 'became a spokesman for the logic of the East only after thoroughly immersing himself in the logic of the West.'[534] This assumption is also recognised by Noë, who explains that '[w]e've baked materialism into our science at the

[534] Nishida (1973). *Art and Morality,* p.x.

lowest level, and as a result, our science can make no room for mind and life.'[535] Nishida will also be shown to view such positivist assumptions as a kind of 'object logic'[536] or 'logic of objects.'[537] Understood solely in the positivist paradigm, Nishida and Noë's world of action and organisation, as well as the phenomenon of entrainment, is merely a system where two or more ontologically distinct "objects" become organised by way of their shared ETMs.

The second positivist assumption is epistemological. Within the positivist paradigm, subjectivity is deemed antithetical to science. *If* there is such a thing as a scientific method, the positivist believes that it must strive to remove all subjectivity. It is only by reducing the effect of subjectivity that objective knowledge about an objective world can be gained. For example, the Vienna Circle's pamphlets states that '[s]ubjectively experienced qualities–redness, pleasure–are as such only experiences, not knowledge.'[538] If reality is an objective realm of "objects" causally interacting, then it makes sense that knowledge about reality needs to be as objective as possible. Because of this, it is thought that scientists should remove subjectivity, as much as possible, from their scientific endeavours.

In *Logical Syntax of Language*, for example, Rudolf Carnap (1891 – 1970) asserts that 'sentences of metaphysics, of the philosophy of values, of ethics […] are pseudo-sentences; they have no logical content, but are expressions of feeling which in their turn stimulate feelings and volitional tendencies on the part of the hearer.'[539] In other words, statements like "murder is evil" or "honesty is good" are not empirically verifiable, as is the case, Carnap argues, for all such value statements. For Carnap, these statements are more aligned with moral psychology than philosophy, placing them within the context of cognitive science and psychology.

[535] Noë (2023). *The Entanglement.* p.199.
[536] Nishida (1987). *Last Writings.* p.54.
[537] Ibid. p.49.
[538] Vienna Circle (1929). *The Scientific Conception of the World*. pp.309 – 310.
[539] Rudolf Carnap (1937; 2001). *Logical Syntax of Language*. London; Routledge. p.278.

Similarly, in *Empiricism and Sociology*, Otto Neurath (1882 – 1945) discusses the link between aesthetics and teaching, arguing that '*he who knows best what to omit is the best teacher* [as] *to remember simplified pictures is better than to forget accurate figures*.'[540] Like Carnap, Neurath is saying here that value statements about aesthetics are not empirically verifiable. This is because, for Neurath, aesthetics are only empirically verifiable to the extent that they influence human psychology, understanding, and learning. Therefore, just as with value statements about ethics, Neurath posits that statements about aesthetics align with cognitive science and psychology rather than philosophy.

This is the assumption that, as Pablo Garcés-Velástegui explains, '[o]nly those claims that mirror or reflect that objective, law-governed world, are considered 'truth' or 'knowledge' proper.'[541] This assumption necessitates a level of detachment in science, as subjectivity must be omitted, or at least accounted for, in order to discover objective knowledge about a purportedly purely objective reality. Understood in the positivist paradigm, Nishida and Noë's world of action and organisation is an objective phenomenon, as is the phenomenon of entrainment. Therefore, within the positivist paradigm, scientists interested in the phenomenon of entrainment must try to remove the effects of subjectivity from their scientific endeavours.

In Chapter 3, Section 1.3, all of the studies investigating neural entrainment assumed that subjectivity was antithetical to their endeavours. Instead, researchers measured the electrical activity of the brain, looking to measure SS-EPs, instances of CFC, and the emergent synchronisation between neural oscillations. In these studies, the subjectivity of the scientist and, crucially, the participant was omitted. In Chapter 3, Section 2, a similar

[540] Otto Neurath (1973). *Empiricism and Sociology*. Dordrecht; D. Reidel Publishing Company. p.220.
[541] Pablo Garcés-Velástegui (2023). Ways of Knowing Agency and Development: Notes on the Philosophy of Science and the Conduct and Use of Inquiry, *The Journal of Philosophical Economics*. 16(Annual issue), pp.39 – 40.

omission can be found when Cirelli et al. adopted a methodology that aimed to measure SS-EP responses, thus discovering '*direct* evidence for the capacity of the infant's brain to entrain.'[542] Similarly, Harder et al.'s study investigating vocal synchronisation between infants and their caregivers found that, at four months old, 'infants showed this [covocalizing] pattern, whereas the mothers had a predominantly turn-taking pattern.'[543] This study is particularly revealing, as it suggests that subjectivity, specifically that of the caregivers, played a key and important role. Infants' vocalisations appeared to entrain with their caregiver's vocalisation, whereas caregivers only mirrored the infants. In other words, the subjectivity of caregivers, that is, their intention, offered the rhythm of language to their infant.

In Chapter 3, Section 3, we reached the limits of the positivist paradigm with interpersonal studies that necessarily involve subjectivity. Van Dyck et al.'s dancing studies found that participants in the same group synchronised their movements more closely when compared to other groups,[544] and that female participants danced more than male.[545] You cannot remove subjectivity from interpersonal studies such as this, as dancing in a group is, at least in part, an intersubjective and intentional activity. More importantly, as Noë gave, '[w]hen two people dance, their movements and actions and thoughts and perceptions are entrained by the larger organization, the dancing itself.'[546] Similarly, in Chapter 3, Section 3.3.3, Demos et al.'s study comparing 'Spontaneous Vs Intentional Entrainment to a Musical Beat'[547] found that 'participants in the intentional condition exhibited more entrainment with the music […] above chance levels,'[548] asserting that intention can lead to higher levels of

[542] Cirelli et al. (2016). *Measuring Neural Entrainment to Beat and Meter in Infants*. p.8. Emphasis added.
[543] Harder et al. (2015). *A Longitudinal Study of Coordination in Mother-infant Vocal Interaction*. p.1786.
[544] Van Dyck et al. (2013). *The Impact of the Bass Drum on Human Dance Movement*. p.357.
[545] Ibid. p.357.
[546] Noë (2015). *Strange Tools*. p.12
[547] Demos et al. (2010). *Spontaneous Vs Intentional Entrainment*. pp.1 – 4.
[548] Ibid. p.4.

entrainment. Whether in cognitive science, psychology, social science, or even anthropology, the positivist assumption that subjectivity is antithetical to the scientific method causes significant problems. It does not fully account for interpersonal and intentional activities, leading Demos et al. to make an erroneous distinction between intentional and spontaneous entrainment. This is a mistake, and will be the topic of Section 3.1 to follow.

The third positivist assumption is methodological. Within the positivist paradigm, true knowledge about reality can only be achieved by the methods of observation or logical analysis. It is assumed that empiricism and experimentation can discover objective truths about an objective world. This is because positivists assume, if only implicitly at times, that reality displays a logical structure that can be corresponded with. In this context, "correspond" relates to the purportedly congruent relationship between our knowledge, derived by observation and logical analysis, and the logical structure of the of reality.

For example, when investigating the social determinants of health, researchers often examine how income levels, education, political efficacy, and access to health care impact health outcomes. When strong correlations are found between lower socioeconomic status and poorer health outcomes, this corresponds with a logical and conditional view of reality: If a person is of lower socioeconomic status, then that person is more likely to experience poorer health outcomes. Thus, the observed correlation reflects a reality where socioeconomic factors influence health. This assumption is explicitly captured in the title of Rudolf Carnap's (1891–1970) 1967 book, *The Logical Structure of the World. Pseudoproblems in Philosophy*.[549] A key member of the Vienna Circle, Carnap's title makes it clear from the start: reality has a logical structure, and many of the problems in philosophy and science are due to a lack of correspondence with said structure.

[549] Rudolf Carnap, and Rolf A. George (1967). *The Logical Structure of the World. Pseudoproblems in Philosophy.* Berkley and Los Angeles; University of California Press.

This kind of assumption, Noë explains, 'brings into focus the limits of positive science and the inescapable need for the modes of reflective exploration that are art and philosophy.'[550] It removes the humanity from science. Understood in the positivist paradigm, knowledge about Nishida and Noë's world of action and organisation, as well as the phenomenon of entrainment, can only be achieved by way of observation or logical analysis. An ORDER system, thus understood, displays a logical structure where two or more non-contradictory "objects" become organised by way of their shared ETMs. This correspondence between logic and reality was particularly evident in Chapter 2, Section 3, when Strogatz et al. used mathematical formulae to describe and explain the entrainment between pedestrians and the Millennium Bridge, under the assumption that their created mathematical model corresponded to the logical structure of reality.

Nishida, as we saw, calls this 'object logic,'[551] or the 'logic of objects,'[552] what he deems to be a Western contrivance that can be dated back to Aristotle who, long before the Vienna Circle, writes: '[t]o say that what is is not, or that what is not is, is false; but to say that what is is, and what is not is not, is true.'[553] This is the law of non-contradiction which rejects the possibility of any epistemological, logical, and ontological contradictions. This law allows for A = A, but dismisses the possibility for A = ¬A. The law of non-contradiction rejects the logic of *soku hi*, as discussed in Chapter 1, Section 2. In *soku hi*, all absolute contradictories are unified; A = ¬A. For positivists, the logic of *soku hi* is a misnomer, as A and ¬A, 有 and 無, *you* and *wu*, being and nonbeing, presence and nonpresence, existence and nonexistence, and so on, are all logical and ontological contradictions. They cannot coexist. A positivist ontology is a realm of objects causally interacting with each other, and

[550] Noë (2023). *The Entanglement.* p.32.
[551] Nishida (1987). *Last Writings.* p.54.
[552] Ibid. p.49.
[553] Aristotle, and Hugh Tredennick (1961). *Metaphysics*. Cambridge, Massachusetts; Harvard University Press. 1011b25, p.201.

where all logical and ontological contradictions are impossible. Therefore, these three positivist assumptions shape science, implicitly informing research questions, methodologies, and the interpretations of findings.

Now that we have discussed positivism, and how it assumes a congruent understanding of knowledge, logic, and reality, it is vital that we contrast this with the logic of *soku hi*. In Chapter 1, Section 2, *soku hi* was described as the logical structure of reality in which *kōiteki chokkan* corresponds. To reiterate, in this context, "correspond" relates to the coherent relationship between our knowledge and the logical structure of the of reality that is offered by *soku hi*. *Kōiteki* is not *chokkan*; action is not intuition. Yet, situated within the logical structure of *soku hi*, all are unified, as are the entanglement of art, life, and entrainment, as we will see in later sections. Because positivists do not allow for logical and ontological contradictions such as this, it is crucial that we investigate how *soku hi* challenges the previously given assumptions before showing how *soku hi* unifies art, life, and entrainment, and how this entanglement shapes what we are.

1.2 Nishida's Philosophy of Science

Nishida's philosophy of science is suggestive but ultimately elusive. For Nishida, 'object logic'[554] in science is erroneous, as science, he argues, is not in the business of describing, explaining, or even corresponding with reality, at least, not in the way that positivists claim.

Nishida deems science to be one of two paradigm examples of *kōiteki chokkan*, the second, as shown in Chapter 1, being art. Maraldo explains that 'we may understand [*kōiteki chokkan*] not only as placing the scientist within the world, but also as implying that the

[554] Nishida (1987). *Last Writings*. p.54.

world is re-created through scientific activity.'[555] It needs to be noted that, as previously mentioned, Nishida does resonate here with other paradigms in science, specifically *antipositivism*, as will Noë with *postpositivism* in later sections. While there are interesting parallels to be found here, let us maintain our focus on positivist paradigm that Nishida is responding to. This is because, as Maraldo goes on to explain, for Nishida, '[r]ather than simply being there independent of our understanding and actions, the world is transformed through them and reciprocally re-creates us.'[556] In other words, in the world of *kōiteki chokkan*, science is an activity that shapes the world which, in turn, shapes the activity of science.

Articulated in *Last Writings*, a collection of essays compiled in the last months of his life, Nishida writes that '[a]ctive intuition is fundamental even for science. Science itself is grounded in the fact that we see *by becoming things* and hear *by becoming things*.'[557] Science entails scientific actions and intuitions. It is a creative and human activity, just like art, where scientists create in and with the world. Scientists both act in and intuit the world, thereby shaping the world which in turn shapes science. Thus, for Nishida, science exists in the world of *kōiteki chokkan*, as does art.

However, Nishida's philosophy of science is far less developed than his examination of art. Tanabe Hajime 田辺 元 (1885 – 1962), a Japanese philosopher of science, criticises Nishida on a similar point:

> If *kōiteki chokkan* is a kind of instinct guided by a learned skill, then it is a kind of naturalism, an intuitionistic vitalism (*seimeishugi* 生命主義), which destroys the true meaning of practical action. On the contrary, if *kōiteki chokkan* is but an intellectual

[555] Maraldo (2017). *Japanese Philosophy in the Making*. p.212.
[556] Ibid. p.212.
[557] Nishida (1987). *Last Writings*. p.102.

> intuition, everything becomes the content of the self-conscious intuition of Nothingness. Then again, the meaning of action is lost in a sort of contemplativism.[558]

Tanabe thinks that *kōiteki chokkan*, in both science and art, is either a learned or purely intellectual skill, thus overlooking the importance of practical action. As should be evident by now, Tanabe's criticism is largely unfounded.

To address this, we must further develop Nishida's understanding of science, returning to the comparable examples of art discussed in Chapter 1, determining how applicable it is, if at all. This is because, if science is a paradigm example of *kōiteki chokkan*, just like art, then artistic actions and intuitions can tell us much about their scientific counterparts.

In *Last Writings*,[559] Nishida's concept of "interexpression" provides a comprehensive understanding of the artist's immersion into the objective and active world. Nishida's interexpression is best understood as an ontological descriptor for the unfolding structure of reality, as it develops his idea that what we create also creates us.

When discussing the relation between the active reality, which he equates with "God,"[560] and the active individual, Nishida describes a reciprocal relationship with no fixed goals or hierarchical structures. Nishida explains:

> [t]he absolute does not destroy the relative; it possesses itself and sees itself in its own absolute self-negation. That which stands in relation to the absolute as its self-negation must itself be self-expressive through its own self-negation. Thus the relation

[558] Cestari (1998). *The Knowing Body*. p.203.
[559] Nishida (1987). *Last Writings.*
[560] Nishida uses the term "God" is quite different from the transcendental and anthropomorphic God found in many Western and Abrahamic traditions. For him, God is the immanent and active reality in which we are all active parts.

> between God and mankind is always to be understood as dynamically interexpressive based on the principle of self-negation.[561]

Notably, this interexpression is grounded in Nishida's ontology, specifically his notion of the "infinite continuity of acts," which will be discussed in detail in Section 1.2.3 to follow. The key point, for the moment, is that Nishida is saying here that the relationship between the absolute (i.e., active reality) and the relative (i.e., active individual) is a reciprocal process of mutual self-negation. The absolute expresses itself by negating its absoluteness, and the relative expresses itself by negating its relativeness.

In the context of art, this self-negation and interexpression is exemplified by the interactions between the artist and the objective world. Through self-negation, the absolute reality and relative artist are mutually negated, resulting in an expression and creation that surpasses both. The artist is self-negated when they immerse themselves in the objective world, allowing it to shape their actions and intuitions. Conversely, the objective world is self-negated through the actions and intuitions of the artist. This interaction shows that artistic expression is a dialogue with the objective world, not just a solitary act. Nishida further explains:

> self-negation requires an articulation of the absolutely contradictory identity of that which forms itself expressively, that which is infinitely creative, and that which is created and creates, which is made and makes. The relation between creative and created is then the dynamic interface between that which is expressive (creative) and that which is expressed and which responds expressively (the created). [562]

[561] Nishida (1987). *Last Writings.* p.103.
[562] Ibid. p.103.

Like Noë, who argues that we are 'a quintessentially aesthetic phenomenon [that] refuses to present itself as a stable object,'[563] Nishida is saying here that the artist's "individuality" is not fixed or static, but rather unfolds through their engagement with their art, as well as with the objective world. Thus, for Nishida, art, artist, and world are revealed and shaped through a process of mutual interexpression.

In the example of *Poet on a Mountaintop* from Chapter 1, Nishida's interexpression is illustrated by the relationship between Shen Zhou and the mountains of *Suzhou*. Shen Zhou's intuitive understanding of *Suzhou'*s many different vistas was shaped by his artistic activities walking the mountains and making sketches from different perspectives. Having immersed himself thoroughly in the landscape, each brush stroke became a dialogue between his experiences and the objective reality of the mountains. By negating his limited perspective, Shen Zhou was able to reveal the true objectivity of the mountains of *Suzhou*, simultaneously expressing all perspectives and none in his creation.

This interexpression also applies to the mountains themselves. The mountains of *Suzhou*, like all of reality, are not passive or static objects to be depicted, but active participants in the creative process; they are *acts*. No singular perspective or mere snapshot can fully capture their ever-changing and ever-transforming nature. When the mountains of *Suzhou* engaged with Shen Zhou, shaping his different perspectives and guiding his artistic actions and intuitions, this, once again, allowed Shen Zhou to express the ever-changing nature *Suzhou*, making *Poet in a Mountaintop* a work of art that both includes and transcends all perspectives. Through this process of self-negation, Shen Zhou was able to immerse himself in the objective reality of the mountains which, in turn, immersed in the subjectivity of Shen Zhou.

[563] Noë (2023). *The Entanglement.* p.143.

This interexpression is at the core of *kōiteki chokkan*, as Nishida previously argued that we exist within a world our reciprocal making.[564] In short, Nishida's concept of "interexpression" shows that art is the enactment of an artist and a world. While this touches upon topics and themes beyond the scope of this discussion, the relevant point is that, for Nishida, art is created by the ambiguity and interplay between individual acts and the active world. When explaining this relation, Nishida gives that

> [t]he religiously active individual therefore encounters God or Buddha in the intimately personal dimension of interexpression through mutual affirmation and negation. "The self faces the absolute at the limit point of its own individual will. God, too, faces the self in his absolute will." Active religious expression must be *ec-static*—a leap of faith in that existential dimension wherein the act is the contradictory identity of transcendent and immanent planes of self-awareness. The act always has the paradoxical form of active intuition.[565]

This is similar to Noë, who argues in *Strange Tools* 'that art offers, sometimes, nothing less than ecstasy. Indeed, it explains it. Ecstasy means, literally, getting out of one's self, or one's state (*ek* "out" and *stasis* "state or condition").'[566] Likewise, Nishida is saying here that *kōiteki chokkan* allows us to liberate ourselves from the limitations of our subjectivity. It allows us to immerse ourselves in, and thus express, the objective reality. However, as we saw in Chapter 1, Nishida is primarily interested in how *kōiteki chokkan* allows the artist to "break free" by way of self-cultivation, whereas Noë is more interested what this liberation entails in the world, which he described as 'the work *the art itself* achieves.'[567] While both perspectives are compatible, as shown in Chapter 1, the latter shall be the main focus going

[564] Nishida (1937). *The Historical Body*. p.48.
[565] Nishida (1987). *Last Writings.* p.39. Emphasis added.
[566] Noë (2015). *Strange Tools*. p.72.
[567] Ibid. p.167

forward, provided that we keep in mind that Nishida's interexpression is a key element in the world of action and organisation.

In summary, Nishida's concept of "interexpression" provides a way of understanding the ambiguity and interplay between artists, their creations, and the objective world. It shows that art is not merely a solitary or subjective act of creation, but a dialogue with an objective world that both includes and transcends the artists subjectivity. By their self-negation, artist and world are mutually shaped. Art, therefore, is the enactment and interexpression of an artist's subjectivity and an objective world, showing how creativity is ongoing process of making and being made.

If, as Nishida asserts, art and science are both examples of *kōiteki chokkan*, then Shen Zhou's methodology is also applicable to science. Like Shen Zhou, scientists also have a deep familiarity with the world. This familiarity can be cultivated by studying physics, mathematics, astronomy, engineering, and so forth. It can also be cultivated by their scientific actions, such as conducting experiments, performing studies, creating models, collecting samples, and so on. Having had their fill of scientific "vistas," scientists can then immerse themselves in and intuit the world, which in turn shapes their scientific activities. In this way, Nishida believes, scientific activities give rise to scientific intuitions, as do scientific intuitions give rise to scientific activities. By this understanding, all scientific creations are created in and with the world. Like it did with *Shen Zhou*, the world beckons scientific activities and intuitions.

Isaac Newton (1642 – 1727), for example, studied physics, mathematics, and astronomy, most notably Johannes Kepler's (1571 – 1630) laws of planetary motion. Kepler's laws of planetary motion were themselves shaped by the work of Nicolaus Copernicus (1473 – 1543), who *may* have been inspired by Aristarchus of Samos (310 – 230), and so on. It was

Newton's scientific activities and deep scientific knowledge that allowed him to intuit the world, thus giving rise his three universal laws of motion.[568] The intuition of *kōiteki chokkan*, as we saw in Chapter 1, is very much an activity; it is not a passive intuition, as is typically associated with the word. Newton's many scientific activities gave rise to his scientific intuitions, as did his scientific intuitions give rise to his many scientific actions, which in turn gave rise to his three universal laws of motion. In this way, the sociohistorical world beckoned Newton to create his laws of motion, as did the physical and biological world.

Importantly, Newton's laws of motion also beckon to the world, or, as is more likely, to other scientists. Like *Poet on a Mountaintop*, Newton's laws of motion invites others to experience, to truly appreciate, the "greatness" of reality. Like Copernicus and Kepler before him, Newton's scientific activities and intuitions were offered to the world, shaping the scientific activities and intuitions of those that came after.

Nishida's concept of "interexpression" again provides a way of understanding the ambiguity and interplay between scientists, their creations, and the objective world. Science is not merely a solitary or subjective act of creation, but a dialogue with an objective world that both includes and transcends the scientists subjectivity. By way of mutual self-negation, scientist and world are mutually shaped. Thus, just like art, science is the enactment and interexpression of subjectivity and an objective world, showing how creativity is ongoing process of making and being made. Science goes on to shape how we intuit the world, resonating through time and influencing subsequent generations of scientists and, more generally, the cultural context in which science is embedded.

[568] Isaac Newton, I. Bernard Cohen, and Anne Whitman (1999). *The Principia: Mathematical Principles of Natural Philosophy.* Berkeley; University of California Press.

Nishida never satisfactorily explains or develops this kind of social praxis in science. While he recognises that science is a creative activity that involves subjectivity, just like art, he never conclusively explains how it is done. In *Last Writings*, Nishida posits that 'the world of science is still a human product, even as a form of the historical world's self-negation. Therefore science is also a form of culture. […] In this sense the world of science may also be said to be religious.'[569] It is difficult to fully grasp what Nishida is saying here. On one hand, he seems to be suggesting that science is comparable to a religious endeavour, in the sense that it is also belief system. In other words, scientific actions and intuitions arise from a belief in science. On the other hand, it is also important to note that how Nishida uses the word "religious," similar to how he uses the word "God," is very different from how it is used in many Western traditions. For him, a religious endeavour or experience arises when we immerse ourselves in the objective reality. This is when a scientist acts in and intuits the world, shaping the world which in turn shapes the creation of science.

Nishida also seems to be saying that science is embedded in culture—a point that Noë will agree with—shaping it from the inside. Maraldo attempts to explain, stating that 'in the form of trans-individual practices, [*kōiteki chokkan*] functions as the agent in creating the world of human cultures and societies.'[570] In other words, *kōiteki chokkan* is a kind of social praxis, where what is and can be created shapes society and culture as much as society and culture shape what is and can be created. While this is an important topic, let us table it for the moment. In fact, as we will see, Noë's *aesthetic paradigm* can develop Nishida's philosophy of science, articulating a framework where science and art shape and get shaped by culture.

[569] Nishida (1987). *Last Writings.* p.118.
[570] Maraldo (2017). *Japanese Philosophy in the Making*. p.212.

1.2.1 Science as a Congruent Representation of Reality

In Chapter 1, Section 5.4, we considered *ikebana*, the Japanese art of flower arrangement. *Kadōka* create flower arrangements that are typically designed to align with 'the order of the cosmos [where] the microcosm imitates the macrocosm.'[571] In other words, *ikebana* does not directly correspond with reality, but rather matches and unifies with it. Just as the vista depicted in *Poet on a Mountaintop* cannot be found in the mountains of *Suzhou*, the order of *ikebana* does not directly correspond to any singular perspective that can be found in the cosmos. However, by including all perspectives and none, *Poet on a Mountaintop* was created to capture and unveil the true nature of the mountains of *Suzhou*, as are works of *ikebana* thought to capture and represent the order of the cosmos.

For Nishida, this would also be applicable to science. Science, he believes, is not an exact depiction of reality, a mere snapshot or singular perspective. Similar to *Poet on a Mountaintop* and *ikebana*, scientific creations capture the true nature of reality without any direct correspondence. Scientific creations, like artistic creations, allow us to appreciate reality and our place within without directly corresponding to it. Scientists mirror the order of the cosmos in their creations. Therefore, for Nishida, science is not in the business of describing or even explaining reality in the way that positivists claim.

It is important to explicitly state that this is not a critique or indictment of science. Similar to the Vienna Circle, many members of The Kyoto School displayed a keen interest contemporary physics.[572] Alongside Nishida, Hajime, and later Jun Tosaka 戸坂 潤 (1900 – 1945) regularly refer to science in their writings, integrating it into nearly all of the major philosophical works. Brink explains that Nishida, Hajime, and Tosaka 'each understood some particular aspect of contemporary physics in some detail, and related their own considerations

[571] Carter (2008). *The Japanese Arts and Self-cultivation*. p.111.
[572] Brink (2021). *Philosophy of Science and The Kyoto School*. pp.9 – 13.

of issues in physics to issues in their own emerging philosophical inquiries—not incidentally, but centrally shaping them in diverse ways.'[573]

The fact that scientific creations do not directly correspond with reality does not diminish their value. To help us understand, Nishida briefly discusses Newtonian and quantum physics:

> Newton's physics, which became the cornerstone of the vast development of modern physical science, if seen from the dynamically human standpoint of ordinary experience, turns out to have been only an "opinion," as present-day relativity and quantum mechanics are bringing out.[574]

This is not a condemnation of Newtonian physics, or of science more generally. When Nishida says that Newtonian physics were an "opinion," what he means is that Newton's scientific actions and intuitions captured and unveiled the true nature of reality without any direct correspondence. Similar to *Poet on a Mountaintop* and *ikebana*, Newtonian physics are a congruent representation of reality, as are the theories of quantum physics that succeeded them. Of the two, Nishida deems quantum physics the superior, as it displays aspects of reality that Newton was unaware of. The relevant point here, for Nishida, is that science creates congruent representation of reality without directly corresponding to it.

Consider how, in Chapter 2, Section 1, when Huygens observed the entrainment between two pendula it was his deep familiarity with mathematics, physics, astronomy, and engineering that allowed him to intuit the world. This led to the creation of his seminal book, *Horologium Oscillatorium*,[575] in which Huygens offered diagrams and equations that he believed directly corresponded with the phenomenon he observed.

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[573] Brink (2021). *Philosophy of Science and The Kyoto School*. p.13.
[574] Nishida (1987). *Last Writings.* p.114.
[575] Huygens (1707). *Horologium Oscillatorium.*

Of the latter, Nishida would expectedly disagree. For him, Huygens' diagrams and equations captured and unveiled the true nature of what we call entrainment. Huygens' work also evoked further scientific intuitions and activities, such as those discussed in Chapter 3. Once again, researchers investigating neuroecological entrainment attempt to give explanations and descriptions of reality by measuring the electrical activity of brains, movements, and so on. However, this does not mean that the idea of entrainment lacks merit, as it allows us to understand and know reality, albeit a kind of knowledge that is quite different from that posited by positivists.

1.2.2 Knowledge by Becoming

According to Nishida, true knowledge about reality can only be achieved through *kōiteki chokkan*. James W. Heisig explains: 'there is no way to step outside of reality in order to know it. The highest form of knowing has to take place from a point at which the knower and the known are one.'[576] Put another way, knowledge is evoked by our actions and intuitions within the world. Like *ikebana*, which, as Carter previously explained in Chapter 1, communicates 'teachings concerning how one should relate to other people, to nature, and to the cosmos,'[577] the science of entrainment can communicate knowledge even though it does not directly correspond with reality. Thus, for Nishida, true knowledge about reality can only be achieved when a scientist acts in and intuits the world, meaning that subjectivity is a fundamental part of doing science.

As Heisig describes it, this is 'knowing by becoming.'[578] This is not a passive knowledge, as Heisig explains further:

> The idea of a kind of knowing without a knowing subject [does] not mean a sort of passivity or quietism in which one is lost in a cloud of unknowing. Neither could it be

[576] Heisig (2001). *Philosophers of Nothingness.* p.51.
[577] Carter (2008). *The Japanese Arts and Self-cultivation*. p.3.
[578] Heisig (2001). *Philosophers of Nothingness.* p.53.

> a mere unconscious event. It had to be experienced as a working in which one participates fully aware but without setting oneself up in the position of either passive spectator or active controller of what is wrought.[579]

Scientific activities, in other words, evoke scientific intuitions, and vice versa. Studies looking at entrainment evoke further scientific intuitions, which in turn evoke further scientific activities looking at entrainment. In this way, knowledge about entrainment is achieved by the scientist. Thus, for Nishida, the idea of entrainment provides a way to actively intuit and understanding reality, which itself includes the act or event of entrainment.

Nishida believes that scientific theories are creations formed both in and with the objective world, just like artistic creations. Scientists are not detached from the world, a mere observer, but an active part. According to Nishida, achieving true objectivity in science is impossible, as science is partially a subjective activity. David A. Dilworth explains:

> Nishida does not denigrate our rational functions, but sees even the most abstract deliverances of the physical and mathematical sciences as having their concrete ground in what he calls active intuition. The world's immediate, dynamic character is the final ground of the meaning of "active" in his notion of active intuition, which always entails the mutual revealment of self and world.[580]

In science and art, subjectivity shapes the objective world, which in turn shapes subjectivity. This is the world of *kōiteki chokkan*, which both shapes and gets shaped by what we are and do. Scientific activities evoke scientific intuitions, as do scientific intuitions evoke scientific activities. Science does not correspond with objective reality, with scientists being mere

[579] Heisig (2001). *Philosophers of Nothingness*. p.53.
[580] David A. Dilworth (1987). Introduction: Nishida's Critique of the Religious Consciousness, In - Nishida (1987). *Last Writings*. p.19.

detached observers. This is impossible. Therefore, for Nishida, subjectivity is a fundamental part of science.

To reiterate a point from the introduction, this dissertation is not about consciousness. Nor is it about subjectivity, intentionality, phenomenal experience, perception, qualia, (free) will, and so forth. In Chapter 1, both authors were shown to disagree about the role of the artist. For Nishida, art is not merely the subjective creation of an artist that then (and only then) works to reorganise life, as suggested by Noë, but rather the creative activity of the world that both includes and transcends all human subjectivity. In other words, for Nishida, art, and by extension science, unfolds and persists through the created work, as what the scientist both shapes and gets shaped by their creation. Noë never discuss science in these terms. For him, as the following Section 1.3 will show, science is the creation of a preexisting scientist who is informed by preexisting organised activities. Therefore, while Nishida and Noë largely agree that we live and create in a world of action and organisation, and that much of what the scientist can and will do is shaped by a world that both transcends and includes their actions, intuitions, and thoughts, both authors disagree about the role of the scientist therein.

1.2.3 Nishida's Ontology

After attending a 1937 talk by physicist Niels Bohr (1885 – 1962), Nishida attempts to articulate his underlying ontology using the example of quantum mechanics. This is particularly helpful, as Nishida's (mis-)understanding of quantum mechanics reveals his own ontological assumptions:

> In micro-physics, the observation of the experimental observer changes the thing being observed. […] However, the physics until now would have said the thing existed whether we observed it or not. Astronomical observations do not alter the

> astrophysical relations, in the old view. A star is a star; observation of it is irrelevant to its physical properties. […] Present-day physics has advanced beyond that position, giving rise to the intricacies of quantum mechanics.[581]

Nishida never states what he means by present-day physics, nor do we know which of Bohr's talks that he attended. Over ten days, Bohr gave ten talks in the Imperial Universities of Tokyo, Tohoku, Kyoto, and Osaka, covering a different topic each day. Bohr spent most of his time in Tokyo, giving talks on atomic theory, quantum mechanics, and the relationship between quantum mechanics and philosophy.[582] In Kyoto Imperial University, where Nishida was active at the time, Bohr gave just one talk discussing the atomic nucleus.

Nevertheless, when Nishida says that 'physics until now would have said the thing existed whether we observed it or not,'[583] he is likely to be alluding to experiments in quantum mechanics that investigate wave-particle duality, specifically those that *seem* to show that quantum entities behave differently when observed. In very simple terms, these experiments, most notably the two-slit experiment, suggest that observation *may* collapse the wave functions of quantum entities. Quantum entities apparently behave like waves when unobserved and particles when observed.

If Nishida is referring to the collapse of wave functions when he mentions that the 'observer changes the thing being observed,'[584] then he correctly recognises the difference between collapsing wave functions and Heisenberg's uncertainty principle. The latter is when the act of measuring something effects its behaviour. However, Nishida appears to be suggesting that it is observation, as in the consciousness of an observer, which causes the collapse of wave functions. This would align with Nishida's wider view that we both shape

[581] Nishida (1937). *The Historical Body*. p.49.
[582] For Bohr's full schedule in Japan, see - Lei Wang, and Jian Yang (2017). Process and Impact of Niels Bohr's Visit to Japan and China in 1937: A Comparative Perspective, *Endeavour (New Series)*. 41(1), p.14.
[583] Nishida (1937). *The Historical Body*. p.49.
[584] Ibid. p.49.

and get shaped by our creations, as throughout his vast corpus, especially in the later periods, 'Nishida variously argues for will to play a role in the very generation of space and time.'[585]

While Nishida may well be correct that subjectivity, as in conscious experience, can shape reality, in the sense that subjectivity and objectivity are unified—this "quantum weirdness" largely remains a mystery today—his interpretation is extremely controversial and, to say the least, very much an outlier. Whether or not he is correct, this reveals his assertion that subjectivity is integral to science. For Nishida, subjectivity, quite literally, shapes reality. Thus, for Nishida, science cannot correspond with reality because subjectivity shapes the objective world that shapes subjectivity.

Nishida's claim has far reaching implications. *If* subjectivity can shape reality, then this would require a fundamental shift in how we understand science, and reality more generally. It would require an investigation into the nature of consciousness, as well as its relationship with the fabric of reality. Such a paradigm shift in science would demand a re-evaluation, and perhaps dismissal, of much, if not all, of what we believe we know about the world and universe. Therefore, while the idea of subjectivity shaping reality is not unique to Nishida, it is a suggestive claim, and its accuracy and implications extend far beyond the given scope of this dissertation.

For Nishida, there is another reason science cannot correspond with reality: reality does not display the type of logical structure that can be corresponded with, at least not with the kind of formal logic advocated for by positivists. In Chapter 1, Section 2, the logic of *soku hi*, where A and ¬A, 有 and 無, *you* and *wu*, being and nonbeing, presence and nonpresence, existence and nonexistence, was shown to find only ambiguity between what is

[585] Brink (2021). *Philosophy of Science and The Kyoto School*. p.17.

and is not, '*soku-hi* […] expresses the dialectical identity of absolute contradictories.'[586] In other words, *soku hi* is an ontological descriptor for the unity of all contradictions, finding only ambiguity and interplay where positivists find ontologically distinct objects. *Soku hi* is the unity of *kōiteki* and *chokkan*, of action and intuition, of being and nonbeing, presence and nonpresence, *you* and *wu*, A and ¬A, and so on. Thus, for Nishida, while reality does have a logical structure, it is not a structure that positivist science or "Western" logic can correspond to.

In contrast to a positivist ontology, where ontologically distinct "objects" causally interact, *soku hi* is indicative of Nishida's ontology, what could be called a negative ontology, and his most important and significant theory: *basho*. While this topic deserves a more comprehensive explanation than can be provided here, Nishida develops a kind of *predicate logic* to explain the logical structure of *basho*, while also critically engaging with the positivist and object logic of Western science and philosophy. Thomas P. Kasulis explains:

> Nishida proposed a 'logic of the predicate' [where] the primary unit of reality is the event […] By changing the metaphysical priority from substance to event and the logical or syntactic priority from subject to predicate, Nishida's Buddhism-inspired logic is grounded in change or process rather than stasis or essence.[587]

In other words, Nishida offers a logical schema where acts are given priority over objects, and where transformation is the defining feature of reality. This is relevant because it implies that science cannot truly correspond with reality, given that reality is in a constant state of transformation. Thus, scientists can only capture and unveil the true nature of this transformation at given moments. Consequently, direct correspondence is impossible, as there is nothing (and no "thing") to directly correspond with.

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[586] Krummel (2015). *Nishida Kitarō's Chiasmatic Chorology*. p.125. Emphasis added.
[587] Thomas P. Kasulis (1998). Logic in Japan: Nishida's Logic of Basho and Logic of the Predicate, *The Routledge Encyclopedia of Philosophy*. Section 2.

In *Art and Morality*, Nishida alludes to development of his predicate logic, positing that '[r]eality, which is immediate, independent, and concrete, is an infinite internal continuity of pure acts, and the absolute will, or absolute self, is this kind of unity of acts.'[588] Though this topic touches upon rich and complex themes, such as consciousness, (free) will, intentionality, knowledge, time, and the "self," the key point is that, for Nishida, the world and "objects" are *acts*, not static or ontological distinct entities. Reality is ever-changing and ever-transforming, entailing a complex web of interconnected acts that both include and transcend all personal acts such as action, intuition, consciousness, (free) will, intentionality, knowledge, time, the "self," and so on.

In the context of art, Dilworth and Viglielmo explain that, for Nishida, 'the creative activity of the artist or the moral decisions of the self arise […] is analyzed in terms of the *act* of aesthetic expression, the *act* of moral decision, the *act* of reflective judgment, and so forth.'[589] This means that all acts, including artistic activities and intuitions, are part of an active reality that both includes and transcends personal action. Reality is an unfolding activity that includes the *acts* of consciousness, (free) will, intentionality, time, and art. All these acts are congruent instantiations of the unfolding act of reality. Nishida explains that

> [t]his kind of infinite continuity of acts—that is, the infinite acts of the self—becomes projected externally as a world of infinite reality with respect to the present self. But the dialectical unity itself of these two mutually opposing directions is the true self, and hence when the 'self' is self-conscious of the unity of this kind of dialectical contradiction, it can include the infinite external world within itself.[590]

In other words, for Nishida, the "self" is not a static entity within a static world, but an active participant within an active and ever-changing reality. The "self," through awareness and

[588] Nishida (1973). *Art and Morality.* p.74.
[589] Ibid. p.32.
[590] Ibid. p.79.

action, engages with and immerses into the world. This dialectical unity, or *soku hi*, of self and world shows that the acts of action and intuition are unified by the active and unfolding reality in which they are situated.

As discussed in Chapter 1, Section 2, *soku hi* is paradigmatically exemplified in art. For Nishida, artistic actions and intuitions unfold within and with the active world. Consequently, the creation of art is not an enactment of an artist's will onto a passive world. Instead, it involves a mutual and reciprocal engagement where artistic actions and intuitions interact with and shape the active world which, in turn, interacts with and shapes artistic actions and intuitions. Action is not intuition, intuition is not action, and yet both are unified by an active world that includes and transcends both acts. The artist's intuitions shape their actions, their actions shape their intuitions, and their actions and intuitions are acts that shape and get shaped by the active world. The creation of art, therefore, is a congruent act that instantiates the infinite continuity of acts, allowing the artist to actively engage with and express the ever-changing and ever-transforming activity of reality.

1.2.4 Nishida's Ontology and Entrainment

In the context of entrainment, Nishida's ontology can challenge the conventional understanding. For him, the studies discussed in the previous chapters are implicitly influenced by positivist assumptions and, accordingly, assume that entrainment is an emergent phenomenon between static entities within a static world. In the context of Nishida's thought, scientific knowledge about what we call entrainment, whether it is exemplified between pendula, starlings, neural oscillations, or humans, arises from the reciprocity between observer and observed, between action and intuition, with each mutually shaping each other.

In the context of Nishida's predicate logic and infinite continuity of acts, entrainment can be understood as an unfolding act within the active reality. Whether it is in the material, biological, or sociohistorical world, entrainment is a congruent act that instantiates the infinite continuity of acts. It is this that allows the artist to actively engage with and immerse in the ever-changing and ever-transforming activity of reality.

The also highlights an important part of Nishida's philosophy: the role of objectivity in artistic expression. For Nishida, creating art is not about the enactment of one's will or intention, nor is it merely the creation of a preexisting artist that then (and only then) works to reorganise life, as suggested by Noë. Art is the creative activity of an objective world that both includes and transcends all human subjectivity. The creation of art is evoked when the artist immerses themselves in the objective and active world, discarding their subjectivity and allowing the world itself to actively shape the creative process. As already discussed in Chapter 1, Sections 1.3 and 1.5, for Nishida, 'the world is a creative process [a]nd our body is a creative element of that world.'[591] Accordingly, the act of creation must be understood as an expression guided by objective reality, not merely the artist's own subjectivity. This is why, in *Art and Morality*, Nishida asserts that

> [j]ust as the mathematician discovers various mathematical principles, the artist is always newly disclosing the beauty of the objective world. To articulate the essence of the beautiful, we must clarify the objective quality of its object in the same way that we must clarify mathematical objects in elucidating the essence of numbers. [592]

Nishida is saying here that reality has a logical structure, adding that art and beauty (as well as morality) must be guided by the objective reality, not merely by the artist's intentions or will. Art is not the enactment of a self or a will onto a static and external reality, but a

[591] Nishida (1937). *The Historical Body*. p.48.
[592] Nishida (1973). *Art and Morality.* p.6.

revealing of the structure and pattern of reality itself. Similar to Noë, who argued that artists 'seek to bring out and exhibit, to disclose and illuminate, aspects of the way we find ourselves organized,'[593] Nishida is saying here that the artist must seek to immerse themselves in the patterns of the objective world, allowing it to guide their creation. By immersing themselves in the world, artists are not guided by their intentions or will, but rather spontaneously by the structure and patterns of the aspects of reality with which they are engaging. The artist must discard subjectivity, immersing themselves in the objective reality, as only through this immersion can they create works that align with world's objective structure. In doing so, the artist's actions and intuitions are no longer merely subjective, but are acts congruent with the unfolding activity of the objective world.

However, to reiterate, Nishida is far outside contemporary science, so much so that it is difficult to apply his predicate logic and, to a lesser extent, his infinite continuity of acts directly to entrainment. This may suggest a potentially intractable disagreement, as Nishida challenges the positivist foundations of contemporary science. It would require that scientists looking at entrainment view their findings as a depiction of a reality where events and acts are given priority over objects. It would also require that subjectivity and objectivity be viewed as fundamental parts of the scientific process, with true knowledge about reality only being achieved by the interplay between. While such a revaluation of science *might* be necessary in the future, it makes Nishida's ontology difficult to integrate with scientific methodologies looking at entrainment.

It is also important to note that Nishida never discusses the role of *kōiteki chokkan* in science in such a manner. Although he would expectedly be amenable to the idea that science is a congruent representation of reality, just like art, he never fully developed this thought in his vast corpus. Consequently, while we can draw parallels between his ideas, the limitations

[593] Noë (2015). *Strange Tools*. p.16

of such interpretations must be acknowledged. At the same time, we should also be careful not to dismiss his understanding of science as too outlandish, especially given that he never fully developed it himself. Although incomplete, Nishida's philosophy of science offers a valuable perspectives.

Noë's understanding of science, as we will see, can provide a middle ground between positivist paradigms and Nishida's tentative philosophy of science. Noë explains:

> We don't see quarks, true, but this doesn't imply that we have no real access to them. As a comparison, we don't see the emotions of another person, but we are surely directly aware of them. They are not posits, but features of the landscape that immediately show up for us.[594]

In other words, Noë recognises that subjectivity is as much a part of the objective world as quantum particles, albeit in less extreme and fundamentally different way that the way described by Nishida.

It is also important to note that Nishida's philosophy of science may not differ as greatly from the positivists' position as he believes. While, evidently, there are fundamental ontological differences and assumptions, it is likely that positivists, specifically neopositivists, would be quite receptive to the idea that science does not directly correspond with reality. It is rare to find mathematical equations and models, such as Einsteins $E=MC^2$, being posited as directly corresponding with reality. Instead, $E=MC^2$ serves as a tool that unveils and captures the equivalence of mass and energy in the universe. Likewise, when studies looking at entrainment offer findings, these too serve as tools that unveil and capture the nature of what we call entrainment.

[594] Noë (2023). *The Entanglement.* p.213.

However, an irreconcilable problem with Nishida's underdeveloped philosophy of science is that scientific findings cannot be reproduced, this being a core tenet of contemporary science. If scientists, like artists, are viewed as creators that aim to capture the true nature of reality, then no two scientific works can be the same. Like *Poet on a Mountaintop* and *ikebana*, where subjectivity and objectivity are mutually shaped, a created work of science, as Nishida understands it, is a subjective activity created in and with the objective world. For that very reason, each created work of science is unique and cannot be reproduced. While, of course, it is possible to copy created works, as is often the case with artistic works, the originality in the initial creation is inherently unrepeatable for Nishida, as both art and artist are mutually created. Therefore, for Nishida, principles of reproducibility present a significant challenge to the application of *kōiteki chokkan* to science.

1.3 Noë's Aesthetic Paradigm

Noë agrees with Nishida that science and art share some striking similarities, writing that 'science—like art and philosophy—is an aesthetic domain.'[595] For Nishida, science exemplifies *kōiteki chokkan*, where scientific creations shape the world that shapes scientific creations. For Noë, science is a tool that investigates the world of organised activities. Echoing Nishida, Noë argues that positivist paradigms are too limited in scope, to the extent that they contribute to a belief 'that we are dispassionate observers building theories on the basis of evidence, when in fact we are participants.'[596] Like Nishida, Noë identifies science as a partially subjective and, crucially, a culturally embedded activity. Noë explains:

> When we are in the space of the aesthetic, we operate with a different sort of rationality […]. We give reasons, we offer grounds, and we make arguments. But it

[595] Noë (2023). *The Entanglement.* p.107.
[596] Ibid. p.91.

> belongs to the very nature of these reasons, grounds, and arguments that they can never be decisive. We can persuade, but we cannot prove.[597]

Essentially, Noë argues here that science is a tool that investigates the world of organised activities in which it is embedded, while not going as far as to say that science and scientist are mutually created.

Science, as Noë understands it, is not about attaining answers. In the aesthetic domain, knowledge about reality involves subjectivity, as science is inherently discursive. Despite scientists and philosophers adopting logical analysis and reasoning, the activity of scientific investigation is, at its core, an ongoing investigation and persuasive endeavour. Scientific discoveries, conclusions, methodologies, and even empirical evidence are all subject to continuous evaluation. While rationality, validity, soundness, and so forth, can play a role in the persuasiveness of science, these are not its defining feature. This is because the *work* of science, like the *work* of art, is to offer new ways of organisation. Thus, for Noë, science is a culturally embedded human activity that shapes and organises the world which shapes and organises science, meaning that there is a reciprocity between subjectivity and objectivity at the very heart of scientific endeavours.

Like Nishida, Noë argues that science exists within the aesthetic domain, and that it is congruent with reality without any direct correspondence, as scientific theories are persuasive and discursive rather than definitive. Scientists engage in inquiry, reorganising and shaping our understanding of reality. For both authors, scientific knowledge is provisional and open to revision.

While science is a culturally embedded human activity, this does not mean that it cannot still offer knowledge about reality. Noë explains:

[597] Noë (2023). *The Entanglement*. p.238.

> In order to hit the target with my bow and arrow, I need to do something, to take aim and concentrate. The fact that I am an embodied person, embedded in a culturally rich situation, is no obstacle to my sometimes succeeding. In fact, it is that embedding that supplies me not only with the physical means—the bow and the arrow, and the training—but also with the motivation to hit the target in the first place.[598]

In the same way, scientific activities are embedded and situated in culture, with scientists using socially and culturally derived tools to investigate and gain knowledge about the world. A trained archer uses a bow and arrow to hit the target, a trained scientist uses scientific equipment, research questions, methodologies, and interpretations, as well as grants, tenure, universities, and so on. It is these cultural and physical tools that allow the scientist to gain knowledge about the world.

This social praxis builds upon Nishida's understanding, recognising that science is both embodied and embedded in the sociohistorical world. Science is embodied in the sense that it involves the subjectivity of the scientist who acts in and gets acted upon by the world. Resonating strongly with Nishida, Noë also explains:

> science is itself a phenomenon of the lifeworld rather than, as it were, a way of getting outside that everyday familiar world so as to get a truer account of reality. We are in the lifeworld when we do science. […] Indeed, the very distinction between […] subjective and objective, these are drawn inside the lifeworld and presuppose it; they have no application to the lifeworld (or to "reality") itself.[599]

[598] Noë (2023). *The Entanglement.* p.209.
[599] Ibid. p.187.

In other words, science is always done in the given or experienced world, what Edmund Husserl (1859 – 1938) calls the 'lifeworld.'[600] In the lifeworld, the distinction between subjectivity and objectivity is made, not discovered. Objectivity can never truly be achieved in science, as subjectivity is part of science from the start. Thus, for Noë, subjectivity is not antithetical to science, but a fundamental part.

Science is also embedded in culture, with the tools that a scientist makes shaping the world of organised activities, which in turn shapes that tools that a scientist makes. This cultural context does not impede the creation of science, but rather provide tools, methods, and motivations, all of which allow the scientist to investigate and gain knowledge about the world. Thus, Noë offers a social praxis where scientific activities are embedded in culture, while also showing how science arises in a world where maker and made are mutually shaped.

In the context of entrainment, Huygens' diagrams and equations in *Horologium Oscillatorium*[601] provided a foundation for more recent investigations. Similar to how Newtonian physics persuade us to appreciate gravity but do not conclusively demonstrate it, Huygens' diagrams and equations capture and unveil the dynamic and unfolding nature of entrainment. Huygens' diagrams and equations are a tool that reveals the nature of reality, as are Strogatz et al.'s mathematical formulas, Cirelli et al.'s measured SS-EP responses in the brain, as well as the many previous studies looking at entrainment. The relevant point for Noë is that scientists work within the aesthetic domain, investigating material, biological, and sociohistorical phenomena, while seeking to persuade rather than prove their existence. Therefore, scientific creations and theories about entrainment are tools shaped by the cultural context of human inquiry.

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[600] Edmund Husserl (1936; 1970). *The Crisis of European Sciences and Transcendental Phenomenology: An Introduction to Phenomenological Philosophy*. Illinois, United States; Northwestern University Press.
[601] Huygens (1707). *Horologium Oscillatorium.*

Nishida can also support Noë's understanding of science, most notably in regards to the role of the scientist. As shown in the previous section, for Nishida the scientist is not detached from the world and culture, a mere observer, but an active part. While many scientists do aspire for such detachment, for Nishida, true knowledge arises when the scientist acts in and intuits the world of *kōiteki chokkan*, when both 'knower and the known are one.'[602] This is knowledge by becoming, when the distinction between subjectivity and objectivity dissolves, and when, as Maraldo explained, the scientist 'and work form mutually and are reflected in one another.'[603]

Noë does not advocate for such an understanding of science, where the subjectivity of the scientist literally shapes the world. Nor is he interested in the previously discussed interexpression between the absolute (i.e., active reality) and the relative (i.e., active individual). Noë is primarily interested in what this interrelation entails in the world, as his aesthetic paradigm is such that science and culture form mutually. While, of course, science and culture are situated within a sociohistorical world that includes and transcends active individuals, Noë is only interested in this to the extent that the scientist shapes the world of organised activities which, in turn, shapes the tools that a scientist makes and uses.

Accordingly, for Noë, knowledge is evoked when the scientist acts and intuits the world. In the same way that Shen Zhou's actions in the mountains of *Suzhou* allowed him to intuit the world, thereby shaping each one of his brush strokes, knowledge about the world and entrainment arises when the scientist immerses themselves in the process of creation, neither observing nor controlling it, but rather actively participating in the unfolding of knowledge. In this way, knowledge about entrainment arises when the distinction between subjectivity and objectivity dissolves.

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[602] Heisig (2001). *Philosophers of Nothingness*. p.51.
[603] Maraldo (2017). *Japanese Philosophy in the Making*. p.209.

Scientific knowledge arises from the world of *kōiteki chokkan*, this being an aesthetic domain where subjectivity and objectivity, scientist and world, creator and created, knower and known, are all unified. Accordingly, science is an embodied human activity where the highest kind of knowledge about the world necessarily involves subjectivity. This fundamentally differs from the positivist paradigm which argues that science should strive to be as objective as possible, removing the role of subjectivity and, in some cases, intention. For Nishida and Noë, subjectivity is not antithetical to science and attaining knowledge about the world, but a fundamental part. Science reflects the embodied scientist and the world in which they are embedded, thus allowing for knowledge to emerge. Thus, science and knowledge arise from a scientific actions and intuition within the material, biological, and sociohistorical world.

1.3.1 There Can be No Capital-S Science

While Noë agrees with Nishida that science and art share similarities, there is an important difference between the two. For Nishida, science and art are both paradigm examples of *kōiteki chokkan,* where true knowledge of the world arises from the unity of action and intuition. This is not the case for Noë. For him, science is an organised activity, constrained and governed by scientific norms, paradigms, and ontological assumptions. In this way, science has more in common with dancing than it does with the art of dancing, capital-D Dance.

In Chapter 1, Section 3.3, Noë explained that '[w]hat makes dancing dancing is the way it is embedded in our lives, in particular, the way, by virtue of its embedding, it organizes us. What makes the artist's dancing something other than dancing is the bald fact that it refuses to be embedded in that sort of way.'[604] The *work* of Dance, that is, what Dance does, is to investigate, reorganise, and offer liberation from dancing. In contrast, the *work* of

[604] Noë (2015). *Strange Tools*. p.71.

science is to investigate and explain the world in which it and we are embedded. Thus, for Noë, there can be no capital-S Science.

Noë argues that science has more in common with design than it does with art: '[*d*]*esign*, like science, but unlike art or philosophy, *is* a techne. The thing about design, at least as I use the term, to encompass craft and technology, is that it relies on a clear view of its task, which in turn means it can take for granted measures of success and failure.'[605] For example, in Chapter 3, Section 1.4, researchers investigating neural entrainment conducted experiments with defined goals, such as measuring SS-EPs and CFC, both of which were deemed indicative of emergent synchronisation, while also being constrained by technological and biological limits. In *Strange Tools*, Noë explains that '[p]art of the problem is that neuroscience is straitjacketed […] by the methods of science [and] an ideology about what we are.'[606] Despite innovation, scientific studies on entrainment remain within the domain of science and neuroscience, along with the accompanying norms, paradigms, and ontological assumptions.

Similarly, as discussed in Chapter 3, Section 3.1, we saw that researchers investigating sensorimotor entrainment created tapping studies with the goal of measuring the emergent synchronisation between rhythmic action and a perceived rhythm. These studies were, once again, guided by defined goals, as well as being constrained by technological limitations. Innovation does arise within this domain, with different iterations of tapping studies using different audible and visual stimuli, as well as different frequencies. Nevertheless, tapping studies remain in the domain of science and neuroscience, and the norms, paradigms, and ontological assumptions that come with, all of which shackle and limit what is and can be done by science.

[605] Noë (2023). *The Entanglement.* p.204.
[606] Noë (2015). *Strange Tools*. p.120.

Where art offers liberation, science works within and creates limitations. Science, for Noë, does not disrupt and reorganise life in the way that art does, nor does it affirm reality in the way that Nishida describes. Noë explains:

> Science, like business, or government, or agriculture, is an activity and an undertaking; it is […] a "going concern." And crucially, […] it is an organized and, we might add, normative activity; that is, it operates with standards and a concern to cleave to standards that it is also necessary, sometimes, on the fly, to reevaluate. Science is a techne.[607]

By techne, Noë means that science is a skilful activity, like dancing. It operates within certain norms, paradigms, and ontological assumptions that often require revaluation.

In contrast to science, Noë gives that 'philosophy and art […] are not techne; that is, these are not skillful or disciplined modes of work with settled criteria of success and operative norms. Scientists ask questions and produce answers. Philosophers and artists, in contrast, raze answers in the quest for concealed questions.'[608] Dance, while it can be deemed good or bad, aesthetically pleasing or displeasing, does not have explicit criteria for success and failure—science does. Science is a skilful activity where, as Noë explains, '[s]cientists know what their answers mean, and they are agreed, almost always, in what counts as evidence for or against them.'[609] This is exemplified within positivist paradigms which prioritises observation, empiricism, and logical analysis as appropriate methods for science. Therefore, for Noë, science is not a tool like art or Dance, but a techne like design and dancing.

[607] Noë (2023). *The Entanglement.* pp.202 – 203.
[608] Ibid. pp.202 – 203.
[609] Ibid. p.204.

1.3.2 The Entanglement of Art and Science

In the preface to *The Entanglement*, Noë explicitly states: 'It is no part of my purpose to say No to science, or even to a science of the human. My aim, rather, is to say Yes to art, and to the importance of the aesthetic attitude that art sustains.'[610] This sentiment comes from the previous distinction between art and science. Art disrupts and reorganises the world of organised activities and culture, what Nishida would call the sociohistorical world, while science is an endeavour that investigates and attempts to explain these organised activities. Thus, as Noë understands the term, art is a "tool," whereas science is a techne.

Noë explains that 'art and philosophy are distinct from science and not reducible to it. But this doesn't mean that these distinct domains are entirely independent of each other or that they are utterly unconnected. In fact, they are *entangled*.'[611] To understand how art and science are *entangled*, we must first understand how '[a]rt is not an add-on, a mere cultural extra, but a basic and central part of what makes culture possible,'[612] as how 'we ourselves are products of this entanglement.'[613]

First introduced in *Strange Tools*,[614] and later elaborated on in *The Entanglement*,[615] Noë explains: 'I use the term "entanglement" to refer to the ways in which what we are is changed by the work of reflection, specifically, the work of art.'[616] In other words, entanglement refers to the reciprocity between art and culture, and how our lives both organise and get organised by this reciprocity. Like upward and downward entrainment, and how Gillett's '*two* sources of determinativity,'[617] art organises and reorganises culture, which in turn shapes art. 'Our lives,' Noë explains, 'are shaped and reshaped by art, philosophy, and

[610] Noë (2023). *The Entanglement.* p.xi.
[611] Ibid. p.202.
[612] Ibid. p.3.
[613] ibid. P.8.
[614] Noë (2015). *Strange Tools*. Title.
[615] Noë (2023). *The Entanglement.* Title.
[616] Ibid. P.24
[617] Gillett (2016). *Reduction and Emergence*. p.234..

the aesthetic [because] we are ourselves aesthetic phenomena who are always in the midst of becoming.'[618] For Noë, this is neither an exaggeration nor hyperbole. Art and philosophy, as the subtitle of *The Entanglement* states, literally '*make us what we are.*'[619] In other words, our lives are embedded in culture, with art and philosophy continuously reorganising the organised activities that define who and, crucially, what we can be. Science does not. While, of course, one of humanity's biggest shifts in defining who and what we are occurred during, for example, the European Enlightenment and through the science of the 17th and 18th centuries, for Noë, this shift came from philosophy (and art) operating within science, not from science itself. This is because science operates within the norms and limitations of organized activities and established paradigms, whereas philosophy and art do not.

In *The Structure of Scientific Revolutions*, Thomas S. Kuhn explains how '[n]ormal science does not aim at novelties of fact or theory and, when successful, finds none,'[620] later adding:

> [d]iscovery commences with the awareness of anomaly, i.e., with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science. […] Assimilating a new sort of fact demands a more than additive adjustment of theory, and until that adjustment is completed—until the scientist has learned to see nature in a different way—the new fact is not quite a scientific fact at all.[621]

Kuhn argues here that genuine scientific breakthroughs, or paradigm shifts, are not extensions of the existing scientific knowledge, but arise when existing frameworks are disrupted by anomalies. These anomalies, whether found in nature or in the lab, disrupt and reorganise what science is, requiring a philosophical revaluation of the underlying assumptions that

[618] Noë (2023). *The Entanglement.* p.116.
[619] Ibid. Subtitle.
[620] Kuhn (1970). *The Structure of Scientific Revolutions*. p.52.
[621] Ibid. pp.52 – 53.

define and shape the current scientific paradigm. Like art, these anomalies are "strange tools" that scientists use to investigate, disrupt, and reorganise science, showing what it is and, crucially, what it can be. Thus, if only implicitly, when scientists investigate what it is to do science, creating new scientific methods and so on, they are doing philosophy.

For Noë, what truly distinguishes human culture, that is, what differentiates the sociohistorical realm from the material and biological realms, is art and philosophy. This does not mean that the sociohistorical world is separate and distinct, as Noë asserts that '[i]t is culture, layered on top of biology, that explains how we became human.'[622] Here Noë, like Nishida, recognises that 'we have no hope of isolating our "true nature" in some core that we share with animals and that can be explained in biological terms alone. We are entangled, and we ourselves are products of this entanglement.'[623] Combining Nishida and Noë's terminology, this means that the material, biological, and sociohistorical realms are all entangled, and that what we are is shaped by art and philosophy, not science. Thus, art and culture are entangled, with both shaping each other, as well as much, if not all, of our lives.

Noë's idea of entanglement will require further clarification in subsequent sections. Its significance here is that, despite their notable differences, art and science are inseparably entangled. Art is a tool, science is a techne, and yet both are entangled. To explain the entanglement of art, philosophy, and science, Noë recognises that all three are subjective creations formed within the objective world. Noë explains:

> science depends for its very existence on non-scientific understanding, that is, our extrascientific as well as our prescientific concerns, projects, and values. […] Even when facts of daily life do not enter as premises into the theoretical arguments of

[622] Noë (2023). *The Entanglement.* p.18.
[623] Ibid. p.8.

scientists, it can hardly be forgotten that science is a human undertaking, a kind of work, a vocation.[624]

Noë is saying here that science is a human activity, and, as such, is shaped by the world in which science and scientist are embedded. It is not like the scientist is some magical being, having the ability to detach from the world in order to do science. The scientist is human, just like the rest of us. Thus, for Noë, and likely Nishida too, scientists are not detached from culture and the sociohistorical world, mere observers, but an active participant.

Noë expands on this, arguing that 'it is philosophy and art, or what joins these, what they share—*the aesthetic attitude*—that supports, enables, and sustains science; and so we can say, […] that science depends upon the form of thought that is art and philosophy.'[625] This is why art and philosophy are different from science and, crucially, why both cannot be reduced to it. Science is a techne that uses the creative and philosophical tools provided by art and philosophy. Art and philosophy, in contrast, are creative activities that, as we shall see, can use the techne of science.

Noë explains that, even if scientists do not recognise it, '[p]hilosophy *happens* inside science, because science needs philosophy, as philosophy needs science. They are two, but they have become as one. They are *entangled*.'[626] Art also happens inside science, as science needs creative activities, as will creative activities be shown to need the techne of science. In this way, science is embedded in culture, whereas art and philosophy shape culture and, subsequently, science.

Nishida, when discussing tool-making and tool-use in *Place and Dialectic*, does briefly mention *gijutsu* 技術 or *technē*, explaining that, 'when it comes to the higher animals,

[624] Noë (2023). *The Entanglement.* p.200.
[625] Ibid. p.201.
[626] Ibid. p.205.

we may consider them from our point of view as already possessing tools and even as possessing a certain type of *technē*.'[627] Nishida goes on to add that '[w]hat distinguishes the species of living things and society […] is at the locus where the living thing, transcending itself by means of *technē*.'[628] Nishida is saying here that *technē* allows humans to transcend their material and biological limitations, offering a distinctly social and historical way to engage with and shape the world that shapes us. It situates humans within a dialectical relationship with their surroundings, where they simultaneously shape and are shaped by their use of *technē*. Krummel explains:

> human beings, by embodying the world's historical life, partake in the world's creativity. No longer dictated by the biological *telos* of species maintenance, humanity in creative interaction with its environment is free to establish societies, which Nishida regards as the "species of historical life." *Technē* in that sense is the means whereby life confronts the negating forces of the environment and transcends the bounds set by those conditions.[629]

While Nishida does not directly apply this idea to science, he states here that, similar to Noë's understanding, *technē* is a culturally embedded human activity that blends literal tool use, including the human body, and historical knowledge. In this way, science is a *technē* that develops within the sociohistorical world. Science is entangled with art and philosophy, as it relies on both to investigate and make sense of the sociohistorical world, as well as the activity of doing science. Thus, for Nishida and Noë, science is a *techne* that art and philosophy use to shape the sociohistorical world that, as we will see, shapes what we are.

[627] Nishida (2012). *Place and Dialectic*. p.116.
[628] Ibid. p.116.
[629] Ibid. p.35.

1.4 Summary and Context

In summary, Nishida and Noë challenge positivist paradigms, while also retaining the importance of science as an explanatory tool. Both argue that paradigms that prioritise observation, logical analysis, and objectivity overlook the fact that science is embedded in culture, and that subjectivity is a fundamental part of actually doing science. Within the aesthetic paradigm, knowledge cannot be achieved by way of detached or dispassionate analysis of reality.

Noë's middle way between Nishida and positivism recognises that true knowledge involves both subjectivity and objectivity, where cultural norms and individual assessments shape scientific activities, as do scientific activities shape cultural norms and individual assessments. For Nishida, this is knowing by becoming, as is it for Noë who recognises that we 'are always in the midst of becoming.'[630] In this context, the previous studies on entrainment maintain their explanatory power, offering insights into the world of action and organisation. However, within the aesthetic paradigm, these studies, along with their chosen research questions, methodologies, and derived conclusions, are inherently embedded in culture and subjective activities.

In context, Nishida's rejection and critique of positivist ontologies, bolstered by Noë's aesthetic paradigm, shows how science is embedded in culture and that subjectivity is not antithetical to science. While science and art are entangled, there remain aspects of human existence that resist scientific explanation, highlighting, as Noë puts it, an ''inescapable need for the modes of reflective exploration that are art and philosophy.'[631] Science is a techne that helps us to understand reality, including entrainment, yet often fails to account for

[630] Noë (2023). *The Entanglement.* p.116.
[631] Ibid. p.32.

subjectivity, and how artists often intentionally use spontaneous entrainment as a tool to organise the world of action and organisation.

Section 2: Style and ORDER

Now we get to the crux of the matter: *entrainment can help us understand and explain Nishida and Noë's world of action and organisation, but only to a point.* In the material and biological world, entrainment is relatively straightforward, requiring shared ETMs to spontaneously initiate and sustain an ORDER system. However, in the sociohistorical world—the world of our lived experience and of culture—entrainment is shaped by forces beyond current paradigms in science, most notably in the cognitive and social sciences.

Noë has far more to say than Nishida on this topic. While Nishida argues that art and science are both paradigm examples of *kōiteki chokkan,* he is more concerned with the underlying ontology than its applicability. Furthermore, Nishida's philosophy of science, specifically his assertion that subjectivity shapes the objective world, is so far beyond the purview of contemporary science that it is all but impossible to apply. Noë, in contrast, is explicitly interested in how we both organise and get organised by our inter-subjective activities. He also argues that humans are 'a quintessentially aesthetic phenomenon, [and] that human life refuses to present itself as a stable object for natural science.'[632] Thus, while Nishida provides important nuances, as will be shown, Noë is better situated to show how entrainment is a tool that artists can intentionally use to shape the world of action and organisation.

2.1 The Limits of Science

Science, conventionally understood, excels at creating research questions, methodologies, and interpretations of data, all of which possess explanatory and predictive

[632] Noë (2023). *The Entanglement.* p.143.

power. Replication or reproduction in science, although rarely done in practice,[633] provides a basis for verifying conclusions and findings. Historically, such methodologies have led to astounding advances in technology, while deepening our understanding of the universe and our place within it. However, their successes have led many to the belief that science can, at some point, explain everything, including the complexities of what it is to be human; a grand unifying theory of sorts, including the material, biological, and sociohistorical world.

In this context, the phenomenon of entrainment could be posited as such a theory. It can be identified in all the three realms of existence, allowing science to create research questions, methodologies, and interpretations of data that have explanatory and predictive power about the world and our place within it. This is not the case. While entrainment is a fundamental and inescapable part of our material, biological, and sociohistorical existence, the human experience cannot be described in such a simplistic manner. Entrainment can help us understand what it is to be human, as we will see, but only in part.

Noë explains that '[t]he problem […] is that we have not yet come to grips with the fact that we ourselves are not a fitting subject for this thing that we do called science. We are a dynamic locus of entanglement. We are a problem to ourselves. We are the one thing that admits no fixed points of any kind.'[634] In the world of action and organisation, where what we do shapes the world, including other people, which, in turn, shapes what we do, we are constantly organising and getting organised, ambiguously fluctuating between the two. Because of this, Noë continues, '[t]here can be no serious engagement with ourselves—whether in natural science, cognitive science, or whatever—that tries to sidestep this awesome and potentially liberating fact: that we are ourselves aesthetic phenomena who are

[633] Nicholas J. Rowland, and Matthew J. Spaniol (2023). On Replication in Science: Commentary on Derbyshire et al. (2022)., *Futures & Foresight Science*. 5(2), pp.1 – 3.
[634] Noë (2023). *The Entanglement.* p.200.

always in the midst of becoming.'[635] In the sociohistorical world, our experiences and intentions are all entangled. For this reason, science cannot fully capture the sociohistorical world. It can only partially capture the material and biological, as the dynamic entanglement of our subjective experiences in the world cannot be reduced to simple or quantifiable terms.

For Noë, humans are a constantly unfolding question that science cannot fully answer. Noë explains:

> Neither argument nor empirical science can decide for us what we should do in the face of this onset of blindness or paralysis. Art and philosophy can. But not by giving us principles to decide, or on whose basis we might pass judgment […] but rather by giving us opportunities to see differently, to know better, to enter into relationship with the objects, that is to say, the people and problems, that stand in our way.[636]

In other words, science cannot help us answer the more existential questions about our lives, whereas art and philosophy can. Simply put, as Noë offers, 'there are genuine questions, important ones, that it is not science's business to answer.'[637]

For example, in the 1952 movie, *Ikiru*[638] 生きる (To Live), directed by Akira Kurosawa 黒澤明 (1910 – 1998), a Tokyo-based bureaucrat, Kanji Watanabe, played by Takashi Shimura 志村 喬 (1905 – 1982), is diagnosed with terminal cancer. With his wife dead, and his son seemingly only interested in his pension, Watanabe goes about seeking meaning in his life before he dies. Does he turn to science for this? No. Watanabe looks to art and philosophy.

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[635] Noë (2023). *The Entanglement*. p.116.
[636] Ibid. p.110.
[637] Ibid. p.200.
[638] Akira Kurosawa (1952). *Ikiru*. Japan; Toho Co., Ltd.

Watanabe first tries the Tokyo nightlife, cumulating in a tearful rendition of the ballad *Gondola no Uta* ゴンドラの唄 (The Gondola Song). Finding no solace in the nightlife, Watanabe then spends time with a young woman who, he believes, exuberates the joy and eagerness for life that he feels he is missing. After a brief conversation, where the young woman tells him about the joy she gets from making toys for children, Watanabe decides to use his job as a bureaucrat to help build a playground in a local slum. In Watanabe's final scene, just under two minutes in length, he can be seen rocking on swing in the playground he helped to build, solemnly singing *Gondola no Uta* before he, presumably, dies offscreen.

Gondola no Uta, a work of art, and the young woman's philosophy offered a way for Watanabe to find meaning. When Watanabe found out that he only had months to live, he did not look to science for meaning, but rather art and philosophy. He found solace in the ballad *Gondola no Uta*, as well as the woman's philosophy, the latter inspiring him to contribute to the creation of the playground. Crucially, as Noë explains, '[j]ust as you don't need to be a philosopher to reflect philosophically on your own thoughts, so you don't need to be an artist to work, as an artist would, with skillful activity, doing, making, and expressing.'[639] Accordingly, for Watanabe, works of art and philosophy provided an opportunity to enter into a relationship with his mortality, allowing him to create meaning in his life where he previously had none.

One possible response is that science, just like art and philosophy, can also provide meaning for people. For example, during the COVID-19 pandemic, scientific research became a source of hope for many, as it offered a way to understand and manage the anxieties of the unfolding crisis. However, while science did help explain the nature of the virus, as well as how to combat it, it did not provide a way to alleviate the suffering, grief, and social upheaval.

[639] Noë (2023). *The Entanglement.* p.147.

In 'Finding Meaning Amidst COVID-19: An Existential Positive Psychology Model of Suffering,' Daryl R. Van Tongeren and Sara A. Showalter Van Tongeren provide a model for explaining how people found meaning during the pandemic, arguing that 'cultivating meaning is the primary way to address suffering and allay existential anxiety, eventually leading to flourishing (and potentially growth).'[640] Individuals and communities sought to make sense of their experiences, with Van Tongeren and Showalter Van Tongeren identifying 'relationships (i.e., connecting with others), spirituality (i.e., connecting with the divine), and prosociality (i.e., improving the lives of others) as three chief candidates for ways that building meaning that addresses existential concerns can lead toward flourishing.'[641] These, along with other cultural forms such as literature, film, television, and music, provided connection and meaning in a time of existential crisis, not science. This is what Noë means when he argues 'that there can be a natural science, but, finally, no science of us (at least no physics-like science).'[642] Therefore, unlike science, the work of art and philosophy is existential, in the sense that they make us what we are, what Noë calls our *style*.

2.2 Existential and Embodied Style

It needs immediately noting that when Noë refers to style, he is not talking about fashion, trends, fads, popular culture, and so on. While these are ancillary to style, providing temporary and outward expressions of what we are, Noë's understanding of style is more existential and embodied:

> Style shines in our lives; it is our avatar, our profile picture, the visible face of our image and our schema. Style is the arc that describes what we are, but that also stands there, for others to see, and for us to see, as something that we can actualize more

[640] Daryl R. Van Tongeren and Sara A. Showalter Van Tongeren (2021). Finding Meaning Amidst COVID-19: An Existential Positive Psychology Model of Suffering, *Frontiers in Psychology*.12(641747). p.1.
[641] Van Tongeren and Showalter Van Tongeren (2021). *Finding Meaning Amidst COVID-19*. p.4.
[642] Noë (2023). *The Entanglement.* p.202.

> perfectly, or differently, or that we can now finally try to reject. Style and life are entangled, and it is this entanglement […] that makes human beings always something becoming and unfixed, even to themselves.[643]

In other words, stye is existential, being the embodied expression of what we truly are, as well as the sociohistorical world in which we are embedded. Style permeates every aspect of our existence, defining our interactions with each other and shaping what we can and will do. Thus, for Noë, style is existential, putting what we are on display for all to see.

Style is the embodied expression of what we are, and of the ever-changing norms, ideas, concepts, values, beliefs, traditions, and cultural practices of the sociohistorical world. Importantly, as Noë explains, '[h]uman beings […] *are* movements in style, or processes in style space. This is why we cannot think of a human being as fixed, exhausted by a nature.'[644] Noë is saying here that style is dynamic process where '[w]e make patterns and we are influenced by the patterns that we make.'[645] This is, to use Nishida's previously given terminology, 'a world in which that which is made makes that which makes.'[646] While fashion, trends, fads, and popular culture can play a role in this, no doubt, style is the ever-changeable and embodied expression of what we are, as well as of the ever-changing sociohistorical world in which we are entangled. Noë explains that '[w]e don't merely *have* styles, the way that we have fingerprints. We *inhabit* our styles; we *enact* them.'[647] Style is how we present ourselves, providing a lens for us to engage with the dynamic and transforming sociohistorical world. In short, our style both shapes and gets shaped by the world. To explain, Noë offers five components to style.

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[643] Noë (2023). *The Entanglement*. p.145.
[644] Ibid. p.154.
[645] Ibid. p.147.
[646] Nishida (1937). *The Historical Body.* p.48.
[647] Noë (2023). *The Entanglement.* p.143.

Noë's first component is that 'styles are *visible*, or rather, perceptible; that is, they manifest themselves in what we do in such a way that they are available to others as something for them to recognize.'[648] The rhythm and tempo of your footsteps, the way you gesture with your hands when talking, your posture, how you present yourself to friends and colleagues, your gender identity, how you approach a problem, your accent, your tone of voice, your sense of humour, the movies you enjoy, the music you like, your signature, even the type of pen that you use, all are visible and perceptible expressions of your distinctive style.[649] Your style is the visible expression of who and what you are, and the way that you are shaped by the sociohistorical world. Thus, style is the perceivable expression of what you are: and aesthetic phenomenon.

Noë's second component is that 'style is not merely perceptible; it is also intelligible.'[650] This is evidenced by the fact that '[s]tyle pops out. We can very often confidently recognize who or what someone is by the way that they look and act. People organize themselves *stylistically*.'[651] When we see a friend walking, for example, we can often recognise their gait. The rhythm and tempo of their footsteps, how they move their body and arms, how they hold their head, all of these allow us to recognise our friend. This walking style is far more than your friend's natural walking pattern or gait; it is their walking style. Noë explains:

> You can recognize a person from behind by the way she walks, by her style or manner of movement, but it may be almost impossible to give an adequate explanation of what it is about the walk that lets you pick it out as different from the way someone else walks, and as distinctively pertaining to the *walk*, say, and not to the posture, or

[648] Noë (2023). *The Entanglement*. p.143.
[649] These examples are inspired by Noë's first-person account of sitting in a room with his colleagues, see – Ibid. p.143.
[650] Ibid. pp.143 – 144.
[651] Ibid. pp.148 – 149.

> the attitude, or whatever, and that is so distinctively expressive of this particular person's way of being. You can see it, but you can't say it. Style resists being made explicit.[652]

In other words, style is the implicit and ineffable way that we identify others, and ourselves. We cannot analyse what we observe in an objective or scientific manner, reducing it to just biomechanics, actions, mannerisms, and so on. We just *get* someone's style, intuitively.

In Chapter 2, Section 3, the swaying Millennium bridge was used as an example of entrainment in the sociohistorical world. When pedestrians crossed the swaying bridge, they were caught up in an ORDER system that altered their natural walking patterns, which in turn altered the swaying bridge, and so on. While the natural walking pattern or frequency of humans, dictated by physiology and musculoskeletal limitations, played a key role in this, so did the pedestrians walking style. When pedestrians crossed the Millenium Bridge, their walking style was perceptible and intelligible to those walking around them. Video footage shows many of the braver pedestrians laughing as they mirrored either others walking patterns, some deliberately, most unknowingly.[653] This kind of *normative social influence* is when the behaviour of individuals is "nudged" towards conforming—think of the tendency to face the door of an elevator because everyone else is doing so.[654] In other words, the walking styles of pedestrians were shaped by the perceptible and intelligible walking styles of each other.

Additionally, Noë explains, '[t]o say that style is intelligible is to say that it is a currency of significance that is available to others, and also to ourselves. [W]e *get* each

[652] Noë (2023). *The Entanglement.* pp.69 – 70.
[653] BBC (2024) 2000: Wobbly Millennium Bridge Forced to Close, Originally Broadcast on 10 June 2000, *BBC Archive*.
[654] This idea is typically associate with Solomon Asch's experiments looking at psychology of conformity in the 1950s. However, so called "elevator experiments" were staged for a 1962 Candid Camera television show. Asch never replicated this in a laboratory setting.

other's styles; and our sensitivity to styles is one of the key ways in which we are intelligible to each other.'[655] It is our unique gait that often stands out when walking down the street, allowing people to recognise us simply by the way we are moving. It is common to recognise the gait of a child as similar to their parent, even when the parent is not walking nearby. Our walking style, distinctive to us, is an embodied expression of what we are. Each pedestrian's distinctive gait and style contributed to a collective style of walking on the bridge, as did the collective style of walking, thereby creating a kind of feedback loop between individual and collective style, which in turn altered the swaying bridge that altered walking patterns. This then contributed to the phenomenon of entrainment, further increasing the emergent synchronisation.

Similarly, in Chapter 3, Section 3.3.3, Van Dyck et al.'s dancing study found that participants dancing in the same group matched movements with a greater degree of synchronisation when compared to other groups.[656] Like pedestrians on the Millennium bridge, dancers altered their dancing styles to match each other. These two examples show how style can manifest in long-term patterns and more transient movements. Even when changes in dancing or walking are brief, they are still shaped and organised by long-term styles, which, in turn, shape and organise the short-term style. While this synchronisation may have been intentional (more on this later), dancing and walking are typically performed spontaneously, in the sense that they are typically done without explicit deliberation or reflection. As Noë explains, '[w]hen two people dance, their movements and actions and thoughts and perceptions are entrained by the larger organization, the dancing itself.'[657] Our style of dance is the embodied expression of what we are, and of how we are spontaneously organised by the organised activity of dancing.

[655] Noë (2023). *The Entanglement.* pp.143 – 144.
[656] Van Dyck et al. (2013). *The Impact of the Bass Drum on Human Dance Movement*. p.357.
[657] Noë (2015). *Strange Tools*. p.12

Style, like art and philosophy, is an invitation. It invites those that perceive us to try to understand and comprehend what we are on an existential level. While this might sound hyperbolic, it is actually grounded in the fact that humans mirror each other's styles. Noë explains that 'styles are visible and immediately recognizable; they are also, and this is crucial, imitable. We copy each other mercilessly. We truly are an imitating animal, […] and our tendency to copy is a driving interest in and concern for style; what we imitate is style.'[658] When walking together, the human tendency to entrain their gait with perceived rhythms, including other humans, is, as Schweizer et al. note, 'associated with changing gait variability, step symmetry, walking velocity, walking cadence and step length.'[659] The tendency to mirror each other's gait is much more that a material or biological phenomenon; we also mirror each other's style. As such, 'style finds expression not only in how a person walks and talks, and eats and dresses, but also in how they themselves know and respond to the world.'[660] Our style is perceptible, intelligible, and imitable, meaning that it is the embodied expression of what we are within the sociohistorical world.

Noë's third component is that 'we *inhabit* style.'[661] Style is not something we can choose to slip on and off, like a favourite sweater or a pair of dancing shoes. Noë explains that our '[s]tyle is spontaneous; it just shows itself in the ways that we do what we do; it finds habitual expression. We have no direct choice over style.'[662] Style, as Noë understands it, is not something we typically reflect and deliberate on, but rather something we spontaneously embody. It is how we present who and what we are, on an existential level, to the world. Noë expands further:

[658] Noë (2023). *The Entanglement.* p.144.
[659] Schweizer et al. (2020). *The Correlation Between Rhythm Perception and Gait*. p.83.
[660] Noë (2023). *The Entanglement.* p.149.
[661] Ibid. p.144.
[662] Ibid. p.144.

> To have an identity of one sort or another—and of course we have many identities—is to *inhabit visible, intelligible ways of being and acting*, […]. We have identities because we are active bodies expressing ourselves habitually in the face of others and in the glare of the ways that they know us, and against the background of a history.[663]

How we stand, walk, talk, dance, and sing, our gender, and racial identities, all are created and embodied expressions of the styles that we inhabit.

It needs to be noted that Noë's use of the word "identity" here is quite different from how positivists were shown to. For him, "identity" is not a logical designator, but an aesthetic one, as our "identities" are 'a quintessentially aesthetic phenomenon [that] refuses to present itself as a stable object.'[664] We are a constantly unfolding aesthetic phenomenon, entangled within a constantly unfolding aesthetic paradigm. In this context, there is no fixed "identity" for Noë. Our "identities," as expressed by our style, are embedded in and shaped by the world of action and organisation. This is why art is a strange tool, as it is allows us to transcend and shape style and "identity." In this way, Noë uses the word "identity" in a more contemporary sense than positivists, as familiar categories of identities are actually brief moments within our entangled style.

Keeping this in mind, another key point is that, for Noë, 'style happens in the space in between objectivity and subjectivity; style denies proof, but welcomes insight, wit, and ingenuity.'[665] The reason for this, Noë explains, is that 'style is nothing like a universal or a defining essence. It is not something occult or interior, not DNA, not distinctive feeling; it is rather the arc of coherence that organizes what a person does (including their feelings). […N]ot every New Yorker talks like a New Yorker, and not every Black person "acts

[663] Noë (2023). *The Entanglement.* p.148.
[664] Ibid. p.143.
[665] Ibid. pp.153 – 154.

Black."[666] Both are styles that people inhabit, regardless of whether they are from New York or a Black person. They are the embodied expression of people's style, not of their location, race, DNA, nor any other purported defining or fixed essence.

Because of this, as Noë clarifies, 'you don't choose your style, or if you do, then you choose it in the peculiar sense in which you choose a dialect of your own language.'[667] You can intentionally choose to move to New York, for example, and pursue a kind of life that might spontaneously change your accent. When adopting a new accent, '[y]ou have a sense of what sounds like the right way to talk, and this then shapes how you do talk. You become what you think you are or are supposed to be. This is also how we become men and women, nonbinary, and so on.'[668] Once again, style is the embodied expression of what we are, and of how this is a dynamic and unfolding phenomenon, entangled in the dynamic and unfolding sociohistorical world. So, Noë asks, '[w]hy do (some) New Yorkers talk like New Yorkers? The answer, roughly, is that they talk the ways that they implicitly understand people like them are supposed to talk. And the same goes, I think, for other familiar categories of identity, like gay/straight, Black/White, and so on.'[669] Accordingly, '[w]e enact style. Style names our fluid, evolving, and yet distinctive manners of being in the world,'[670] not any purported defining essence.

For example, in Van Dyck et al.'s previous dancing study, female dancers were observed to move more than their male counterparts.[671] While this disparity could be partially explained in biological and material terms, such as sexual selection and anthropometry, the dancing of participants was also, if not predominantly, spontaneously influenced by the styles provided by gender norms, social norms, personal attitudes, and many more. These

[666] Noë (2023). *The Entanglement*. p.149.
[667] Ibid. p.144.
[668] Ibid. p.145.
[669] Ibid. p.152.
[670] Ibid. p.150.
[671] Van Dyck et al. (2013). *The Impact of the Bass Drum on Human Dance Movement*. p.357.

enactments of style were inhabited by individuals, giving rise to a disparity between how the dancing was performed. Similar to how not every New Yorker has a New York accent, and how not every Black person "acts Black," there are no material or biological foundations to dancing styles, nor is there for any other markers of what we are.

Noë's fourth component is that 'we are typically aware of style, because it is the lens, and the filter, through which we make skillful contact with the world around us, in action, perception, word, or thought.'[672] This is because our styles are embedded in organised activities. Like the organised activity of dancing, style is something we do without explicit training or deliberation, as do our styles necessarily and spontaneously resonate with the styles of others. This is what Noë means when he gives that 'styles […] are enacted by us, and they are enacted by us in a space of significance for others, and so they are present to us, too, as the ways that we find ourselves presenting ourselves to others. To have a style is perforce to be in relation with others and to have a socially amplified self-conception.'[673] Put another way, the embodied expression of our style is constantly resonating with the styles of those around us, spontaneously shaping how we present and perceive ourselves. When we inhabit a style, we are partaking in the sociohistorical world that both shapes and gets shaped by our style.

Noë's fifth component is, 'insofar as we perform or express ourselves stylistically, […] we are ourselves always open to, and, really, alive to criticism.'[674] Being the visible and intelligible style that we inhabit, it is fundamentally an aesthetic phenomenon and, as such, subject to criticism by others. Criticism of style does not necessarily 'pertain to what we like to see, or what pleases us, or feels right, or goes together. [It provides] opportunities for new seeing, for cultivating sensitivity, and for transforming ourselves in the act of bringing

[672] Noë (2023). *The Entanglement.* pp.144 – 145.
[673] Ibid. pp.144 – 145.
[674] Ibid. p.145.

difference, likeness, kinship, opposition, contrast, and concord into view.'[675] Similar to how artists and philosophers intentionally create strange tools that shape and reorganise organised activities, and to how art criticism provides a lens for new kinds of art, criticisms of style offer new ways of expressing our own distinctive style.

In summary, style is the perceptible and intelligible expression of what we are. It is the spontaneous expression of the norms, ideas, concepts, values, beliefs, traditions, and cultural practices that we inhabit and put on display, thereby opening ourselves to criticism and, consequently, allowing for new instantiations of style. This means that our style is an ever-changing aesthetic phenomenon found in the sociohistorical world, just like art. Style goes where science cannot, as it is the constantly unfolding sociohistorical question that has no simple material or biological answer. Thus, our style is a work of art. We are *the* work of art.

Before we look at the links between style and entrainment, and how this links with the overall argument of this dissertation, it is important to note that Nishida does briefly discuss style in *Art and Morality*, explaining that:

> [i]n the case of a painter painting a picture, he, of course, does not follow conceptual judgment; but his painting is not merely spontaneous movement, either. His movement must have the self-awareness of power. It is not reflective self-awareness, but self-awareness in action. 'Style' is such a self-awareness in action.[676]

Nishida uses the term "style" conventionally here, alluding to how it is shaped by the painter's embodied self-awareness. However, for Nishida, the artist's style is not linked to an organised activity in the way described by Noë. Instead, for Nishida, style emerges spontaneously and intuitively from the artist's active self-awareness and creative activities.

[675] Noë (2023). *The Entanglement*. p.145.
[676] Nishida (1973). *Art and Morality.* p.32.

This suggests that style is something that unfolds naturally from the artist's interaction with their medium, and by extension, from their engagement with the world more generally.

The second point is that Nishida suggests that self-awareness is not merely intellectual or reflective, but rather exists within the embodied activity of painting itself. For Nishida, self-awareness is not a mere cognitive process; it is enacted by a mind and a world. This idea foreshadows Nishida's later development of *kōiteki chokkan*, which, as discussed in Chapter 1, Section 4.3, argues that in creation we are created. Artistic activities spontaneously give rise to artistic intuitions, as do artistic intuitions spontaneously give rise to artistic activities. However, this mutual spontaneity is neither random nor arbitrary. It emerges from the embodied and intuitive self-awareness of an artist, and within the act of creation itself. Style emerges from the reciprocity between action and intuition, where self-awareness is constantly shaping and being shaped by the creation of art. Thus, Nishida resonates with Noë, as the artist practices their craft so that they can spontaneously create in and with the world.

The third point of interest is that quotes such as this mark an important shift in Nishida's philosophy, beginning in the later chapters of *Art and Morality*, and further developed in his subsequent works. In their preface to *Art and Morality*, Dilworth and Viglielmo explain this shift:

> the focus of Nishida's attention in *Art and Morality* is the experiential *ground* from which and in which either the creative activity of the artist or the moral decisions of the self arise. […] But his phenomenological analyses always cause Nishida to return to the consideration of the fundamental source of the expressive and volitional self.[677]

In other words, Nishida begins to explore the ontological and metaphysical *ground* of self-expression, creativity, and moral agency in *Art and Morality*. This investigation allows

[677] Nishida (1973). *Art and Morality*. p.32.

Nishida to connect individual acts of creation to their more fundamental engagement with the material, biological, and sociohistorical world. This expansion marks a pivotal moment in Nishida's philosophy, laying the groundwork for his articulation of the world of *kōiteki chokkan* in his later works, which form the basis of this dissertation.

Finally, while Nishida's understanding of style in *Art and Morality* is initially focused on the individual artist, it remains compatible with Noë's more expansive interpretation, as well as Nishida's own world of *kōiteki chokkan* developed in his later works. Nishida's "style" is consistent with his expanded idea of *kōiteki chokkan*, as emphasises the embodied, intuitive, and active creation of art. When Nishida says that style is 'self-awareness in action,'[678] this resonates with Noë's earlier contention that '[h]uman beings […] *are* movements in style, or processes in style space.'[679] Both philosophers seem to agree that style is the embodied expression of the artist. However, while Nishida's earlier writings focus on this individual embodiment, Noë, along with Nishida's later works, expand and deepen this understanding to include the sociohistorical context in which style is embedded. For both, style is not an individual and limited expression of one's "identity," but rather an expression of our active and reciprocal engagement with and within the sociohistorical world. Thus, style is a dynamic and unfolding aesthetic process that is entangled within a dynamic and unfolding aesthetic paradigm.

These three points also touch upon Nishida and Noë's disagreement about the role of the artist, as discussed in Chapter 1, Section 4. For Nishida, art is not merely the creation of a preexisting artist that then (and only then) works to reorganise life, as suggested by Noë, but rather the creative activity of the world that both includes and transcends all human subjectivity. Similarly, for Noë, style is not merely the embodied expression of an artist that

[678] Nishida (1973). *Art and Morality*. p.32.
[679] Noë (2023). *The Entanglement.* p.154.

then (and only then) shapes the world, as Nishida implies in *Art and Morality*, but rather the emerges from the aesthetic paradigm that both includes and transcends all style.

2.3 Entrained Styles

Within Noë's aesthetic paradigm, style cannot be reduced to mere material or biological analysis. Its ever-changing complexity and constant evolution resist objective categorisation, continuously giving rise to new structures of organisation and styles. The sociohistorical world is an unfolding and ever-transforming aesthetic phenomenon, not a static object. This aesthetic paradigm, wherein our personal style is the embodied expression of what we are, is the reason why, 'human life refuses to present itself as a stable object for natural science.'[680] However, this is not to suggest that science is completely irrelevant. It can still enhance our understanding of style, if only to a point. To examine this, we must return to the five features of an ORDER system one last time.

2.3.1 Openness and Dissipation

The first feature of entrainment is that it is an open system. The positivist assumption that reality consists of ontologically distinct objects is increasingly challenged by contemporary science. For example, subatomic particles constitute every "thing" or "object" in the universe. These elementary particles, such as quarks and leptons mediated by bosons, form the basic building blocks and interactions of all matter and energy.[681] While we do attribute names to these "objects," these are names given, not discovered. Like the words "pendulum," "starling," "neuron," "brain," the names "particle," "quark," and "lepton" are used to describe subatomic entities that apparently display both wave-like and particle-like properties. These terms have no direct correspondence with the entity they refer to, meaning that, at the quantum level, it is no more correct to call a particle an "object" that it is to call a

[680] Noë (2023). *The Entanglement*. p.143.
[681] W. N. Cottingham, and D. A. Greenwood, (2023). *An Introduction to the Standard Model of Particle Physics (Second ed.).* Cambridge; Cambridge University Press. Chapter 1, pp. 1 – 19.

pendulum one. Reality is not predicated on independent and ontologically distinct "objects." Instead, what we conventionally understand as separate entities are, ontologically speaking, events or acts. This aligns with Nishida's 'logic of predicate,'[682] where events, not substances or objects, form the fundamental elements of reality.

The third feature of entrainment is that it is a dissipating system. Once again, it is trivially true that every "thing" in the universe is subject to entropy. As Atkins noted in Chapter 1, Section 1.1.1, '[t]here is no prohibition of the system or the surroundings *individually* undergoing a decrease in entropy.'[683] While the overall entropy of the universe tends toward disorder, individual systems can experience decreases in entropy, thus resembling a slight upward peak of order on a generally descending slope. Provided that appropriate mechanisms and processes are in place, most notably entrainment, brief moments of order and organisation, what Schrödinger called 'negentropy,'[684] can emerge.

Combining the first and third features of an ORDER system, openness and dissipation, it can thus be said that there are no truly distinct "objects" within the universe. There are only events and acts of increasing or decreasing entropy. This means that the only true permanent in reality is impermanence, as all "things" exist on a continuum and are in a constant state of transformation. Thus, as the classic Daoist text, *Zhuangzi* 莊子, puts it: 'This is called the transformation of things.'[685]

Like every "thing" within the universe, humans are an open and dissipating system. We are born, get old, and die, with our lives representing a brief upward peak on an otherwise descending slope. In the material and biological world, we transfer and absorb energy, initiating and sustaining brief moments of negentropy. However, in the sociohistorical world,

[682] Kasulis (1998). *Logic in Japan*. Section 2.
[683] Atkins (2010). *The Laws of Thermodynamics*. p.49.
[684] Schrödinger (1944; 1956). *What is life?*
[685] Hyun Höchsmann, Guorong Yang, trans., and Zhuangzi (2016). *The Zhuangzi*. New York; Routledge. Book 2, p.97.

humans also exchange norms, ideas, concepts, values, beliefs, traditions, and cultural practices, all of which shape our distinctive style.

This is grounded in Nishida and Noë's combined world of action and organisation, wherein the active reality includes personal action, and wherein we both organise and get organised by our activities. In the material and biological world, these structures of organisation are relatively straightforward, as the previous two chapters have shown. However, in the sociohistorical world, reality also transcends and includes subjectivity. Actions shape intuition, and intuitions shape action, as do the actions and intuitions of others shape our own, and vice versa. In the sociohistorical world, our style is the perceptible and intelligible expression of what we are, as well as the ever-changing norms, ideas, concepts, values, beliefs, traditions, and cultural practices that we inhabit. Therefore, in the sociohistorical world, action, intuition, and style are socially and culturally embedded, open to structures of organisation that can include the actions, intuitions, and styles of others.

Additionally, the sociohistorical world, like the material and biological world, is in a constant state of transformation. In fact, this is its defining feature. Although it can be partially understood through entropy and dissipation, the transformation in the sociohistorical world is as much existential as it is ontological. The sociohistorical world is always in the midst of change, constantly being organised, reorganised, and reorganised again. This is why there can be no true science of the sociohistorical world, at least, not in the way that there can be a science of the material and biological world.

In the sociohistorical world, the world of culture and organised activities, there is nothing fixed that can be observed or understood by logical analysis because, as Noë previously explained, '[i]t is culture, layered on top of biology, that explains how we became

human.'[686] This is Nishida's tripartite reality, where the material, biological, and sociohistorical realms are simply different standpoints for viewing reality. Yet, the sociohistorical world is something more than the material and biological processes it is layered on top of. It is the *given* or experienced world, Husserl's 'lifeworld,'[687] wherein mind and life are mutually entangled and the products of entanglement.

In the context of Nishida's predicate logic, the sociohistorical world 'is grounded in change or process rather than stasis or essence.'[688] This change or process includes the exchange, and subsequent transformation of norms, ideas, concepts, values, beliefs, traditions, and cultural practices. While this social praxis is still subject to entropy, the transformation it entails is far more complex. It cannot be *fully* captured by the laws of thermodynamics, or by contemporary science more generally.

In contrast to the transformation from order to disorder entailed in entropy, the transformation in the sociohistorical world is discursive and dialectical, involving subjectivity and intention. This social praxis involves a constant reorganisation of organised activities, giving rise to the creation of new cultural practices and styles, which in turn get reorganised, and so on. Our norms, ideas, concepts, values, beliefs, traditions, and cultural practices evolve by way of this continuous process. To put it simply, the primary unit of the sociohistorical world is the unfolding event of style, not a substance or object.

For example, in Chapter 3, Section 3.2.1, Merker et al.'s movement study '[o]n the role and origin of isochrony in human rhythmic entrainment'[689] looked for entrainment between infants and caregivers. Researchers measured the time between infants' movements

[686] Noë (2023). *The Entanglement.* p.18.
[687] Husserl (1936; 1970). *The Crisis of European Sciences and Transcendental Phenomenology.*
[688] Kasulis (1998). *Logic in Japan.* Section 2.
[689] Merker et al. (2016). *On the Role and Origin of Isochrony in Human Rhythmic Entrainment*. Title.

and caregivers' vocalisations, typically in the form of dancing, singing, or music.[690] With the exception of one child, no evidence of entrainment was found, leading Merker et al. to conclude that '[s]ocial situations of music and dancing tend to excite infants […]. In this sense the infant is in fact "dancing", though without the temporal yoking of body movements to the tactus of the music that is the crux of rhythmic entrainment.'[691] In other words, while there were spontaneous material and biological processes at play, such as kinetic mechanical energy being transferred through caregivers' vocalisations, which were then absorbed and transferred into electrical signals by the infants' sensorineural and sensorimotor systems, this was mitigated by the infants' excitement. Simply put, social dynamics mitigated the possibility for entrainment.

This can also explain the one exception, where a young girl potentially entrained her actions with maracas to her caregiver's singing. As Merker et al. noted, this girl had participated in weekly "baby rhythmicity" sessions with her mother throughout her first year of life, leading up to their study. While similar material and biological processes were at play here, the previous social dynamics between the young girl and her caregiver potentially enhanced the capacity for entrainment. Thus, in Merker et al.'s study, the sociohistorical world added a level of complexity that could not be fully captured in their findings.

Accordingly, the sociohistorical world is far more complex than the material and biological. While contemporary science can help to understand and explain material and biological processes, and how humans are open and dissipating systems, it fails to address the complexities of the sociohistorical world. Humans are constantly interacting with and responding to the ever changing cultural and intellectual landscape. This entanglement allows

[690] Merker et al. (2016). *On the Role and Origin of Isochrony in Human Rhythmic Entrainment*. p.12. Footnote.
[691] Ibid. p.12.

for the reorganisation and transformation of culture, as it does allow for the reorganisation and transformation our actions, intuitions, and styles.

2.3.2 Resonating Styles

The second feature of entrainment is that it is a resonating system. Every "thing" has a natural frequency, being the tendency to oscillate within an inherent range of motion even when inert or unmoving. In the material and biological realms, downward resonance is when a higher frequency spontaneously "pulls up" a lower frequency, whereas upward resonance is when a lower frequency spontaneously "pulls down" a higher frequency.

In the context of style, a natural frequency in the sociohistorical world can be understood as the visible and intelligible inherent patterns of behaviour that individuals exhibit within the boundaries of their styles, as well as within the boundaries of their material and biological existence. Just as physical objects resonate with similar natural frequencies, individuals' styles resonate with the similar styles that they perceive, such as others in their immediate social circle. This resonance is not merely a material or biological phenomenon; it extends into the sociohistorical realm where the natural frequency of style spontaneously influences and resonates with societal norms, values, and styles of others. While this tendency operates within the confines of material and biological limitations, it also operates within the confines of the styles that we create within the sociohistorical world.

For example, when pedestrians crossed the Millennium Bridge, their gait was confined by the biomechanical limitations of the human body. This is the natural frequency of a walking human body. However, the way pedestrians walked, as in their style of walking, was far more complex than biomechanical limitations. Pedestrians' style of walking was also confined by the organised activity of walking itself, in the sense that walking is something that we do and learn socially. Walking is the embodied expression of our style, shaping and

confining how we can and do behave. This natural walking frequency is enacted within the sociohistorical world, as having a walking style is both to shape and be shaped by the organized activity of walking. Thus, style has a natural frequency, being our tendency to act in a certain way within the confines of the styles that we inhabit.

For style to resonate, it must be perceived. To be perceived, it must be seen, heard, touched, and so on. To be seen, heard, and touched, it must involve the sensorineural systems, where the process of 'sensory transduction'[692] transforms conducted, radiated, convected, and advected energy into electrical signals in the brain, which then propagate as event-related neural oscillations. Thus, perceiving style is as much a part of the material and biological realm as it is the sociohistorical.

For a style to resonate, it must also be expressed. To be expressed, it must be a kind of embodied movement or action, such as posture, walking, talking, and so on. Embodied movement or action involves the sensorimotor system, where, combined with the neural and sensorineural systems, energy is conducted, radiated, convected, or advected from our bodies to our environment, including other people. Thus, once again, expressing style is as much a part of the material and biological realm as it is the sociohistorical.

Putting both together, for styles to resonate they must be mutually perceived and expressed, involving our neural, sensorineural, and sensorimotor systems. Resonating styles occur when a perceived frequency "pulls up" or "pulls down" an expressed frequency. While upward and downward resonance between styles can occur simultaneously, as exemplified by pedestrians spontaneously synchronising walking styles, they can also occur independently, as exemplified by someone spontaneously adopting a New York accent.

[692] O'Shea (2005). *The Brain*. p.7.

However, while, in part, resonance between perceived and expressed styles can be explained in material and biological terms, style is also intelligible. In other words, for style to resonate, we must *get* someone's style, intuitively. Style is the implicit and ineffable way that we identify ourselves and others. For styles to resonate, they must transcend perception and embodied expression; they must also be intelligible. While style often resonates intuitively, it does not always need to be fully intelligible or consciously grasped. Rather, it can be recognised in a way that is more implicit, where we sense and mirror each other's style without needing to make them explicit or even fully understood. This intelligibility involves intuitively grasping the implicit and ineffable aspects of how people identify themselves. This is what Noë means when he states that '[t]o have a style is perforce to be in relation with others and to have a socially amplified self-conception.'[693] This intuitive resonance is how we identify as men and women, black and white, New Yorker, as well as many other adopted mannerisms and behaviours. Therefore, resonance between styles involves material and biological process overlayed by the implicit and ineffable way that we identify ourselves and others in the sociohistorical world.

For example, research into human gait mechanics has looked at the biological and social factors influencing how people walk. A meta-analysis by Frimenko et al. identified a difference between how biological men and women walk, suggesting that, when physiological differences were accounted for, 'women may walk at a slightly faster preferred speed than men.'[694] Similarly, in 'Swagger, Sway, and Sexuality: Judging Sexual Orientation From Body Motion and Morphology,' Johnson et al. found that '[t]he body's motion—specifically, its gait—is also sexually dimorphic and has been related to judgments of sex and gender. Men and women walk differently […], and these differences are sufficient to support

[693] Noë (2023). *The Entanglement.* pp.144 – 145.
[694] Rebecca Frimenko, Cassie Whitehead, and Dustin Bruening (2014). Do Men and Women Walk Differently? A Review and Meta-Analysis of Sex Difference in Non-Pathological Gait Kinematics, *United States Air Force: Air Force Research Laboratory*. p.1.

sex categorization that is above chance in accuracy.'[695] Similar to how not every New Yorker talks with a New York accent, and to how not every Black person "acts Black," not every biological man or woman walks "like a man" or "like a woman." Within the biomechanical limitations of the human body, there is no right or wrong way to walk, and there are no biological foundations to differences in walking styles between individuals. These are all styles of walking that people inhabit, regardless of their location, sex, gender, race, and so on. They are the embodied expression of how people's style both shapes and gets shaped by the organised activities in which they are embedded. This style has a natural frequency, being the tendency to act in a certain way within the confines of people's biological and sociohistorical existence. Visible and intelligible to others, the styles we inhabit resonate with those around us.

Resonating style in the sociohistorical world is not unconnected from the resonance found in the material and biological world; they are entangled. Style loops down and resonates with the natural frequencies of the world, which in turn resonate with style. When pedestrians walked across the Millenium Bridge, their walking style transferred kinetic energy to the bridge with each footstep, causing the bridge to subtly vibrate. The more pedestrians synchronised their gait and style, the more the bridge swayed and wobbled. The more the bridge swayed and wobbled, the more pedestrians synchronised their gait and style. Therefore, style loops down and resonates with material and biological processes, which in turn resonate with style in the sociohistorical world.

2.3.3 Emergent Style

In Chapter 3, Section 3.3.1, Van Dyck et al.'s movement study found that higher volumes and tempos spontaneously "pulled up" the frequency of dancing, while also

[695] Kerri L. Johnson, Simone Gill, Victoria Reichman, and Louis G. Gill, Tassinary (2007). Swagger, Sway, and Sexuality: Judging Sexual Orientation From Body Motion and Morphology, *Journal of Personality and Social Psychology*. 93(3), p.322.

identifying social dynamics as a key factor. In this study, the natural frequency of each dancer's movements was shaped by the music, individual biomechanical constraints, as well as by the surrounding dancers. As dancers synchronised their movements, this was a kind of upward and downward entrainment that included their material, biological, and social context. The volume and tempo of the music, as well as the other dancers, created a period of emergent synchronisation within each group which spontaneously "pulled up" the natural frequency of their dancing.

Additionally, the dancers' perceivable and intelligible style of dancing, confined by the organised activity of dancing, resonated with each other. One dancer, for example, starts "popping and locking" to the rhythm of the music, expressing the style that they inhabit. A second dancer, in response, intentionally starts to mirror the movements that they perceive and implicitly understand. As the process continues, a synchronisation between the transitory expressions of styles emerges, confined by the rhythm of the music, the biomechanical limitations of the human body, as well as by the more long-term norms, ideas, concepts, values, beliefs, traditions, and cultural practices associated with the organised activity and style of dancing. While dancers can also intentionally stop dancing, or even intentionally not synchronise their movements, this exemplifies how styles can spontaneously and intentionally resonate within the material and biological world, while also in a social context, thus shaping and being shaped by the collective activity of dancing.

Van Dyck et al.'s study also exemplifies how our gender styles and identities resonate within the material, biological, and sociohistorical world. Higher volumes and tempos "pulled up" the frequency of dancing for all dancers, those identifying as female moved more actively than those identifying as male.

For example, “twerking,” a sexually suggestive style of dance, is typically associated with the female gender. While, of course, there are no prohibitions on those identifying as male from twerking, as many will attest, the gender norms, ideas, concepts, values, beliefs, traditions, and cultural practices associated with the organised activity of dancing typically constrain or encode this style of dancing to the female gender. This gendered style of dancing resonates within the wider sociohistorical world, providing a visible and intelligible expression of people’s gender and style. Therefore, the resonance of dancing styles among those that identify as male and female resonates within the broader sociohistorical pattern of gender and expression.

Van Dyck et al.’s study highlights the complex entanglement of entrainment in the material, biological, and sociohistorical world. As the dancers entrain their movements to the perceived music and each other, their styles resonate within a complex yet implicitly intelligible system that increasingly synchronises their movement with perceived material, biological, and social rhythms. The ambiguity and interplay between the material, biological, and sociohistorical realms allow for a resonance that synchronises the collective experience of dancing, thus exemplifying the entanglement of human behavior and social interaction.

2.3.4 Rhythmic Style

In Chapter 2, Section 1.2, rhythm, in the ontological sense, was defined as a recurring, periodic, and oscillating pattern, being a sequence of interrelated events within a natural frequency. In this context, rhythmic style refers to the recurring patterns of behaviour we inhabit, from the rhythm of spoken languages to the rhythm of movement. Harder et al.’s study on vocal synchronisation between infants and caregivers demonstrated this, as the caregiver’s turn-taking pattern created a rhythmic structure to which the infant could entrain.

In this way, language was an embodied expression of the caregiver's style, and of the organised activity of language more generally. The natural rhythm of spoken language offered a recurring, periodic, and oscillating pattern to which infants can entrain, evoking emergent synchronisation and co-vocalization. This was more than a material or biological response, as the embodied expression of the caregiver's style resonated and entrained with infants' neural, sensorineural, and sensorimotor systems. As infants entrained with caregivers, their rhythmic vocalisations were "pulled up" by the rhythmic vocalisation and style of natural spoken language. This shapes and organises the infants' style of vocalisation to align with the organised activity and style of natural spoken languages. In short, caregivers offered the rhythm and style of languages.

Rhythmic style permeates all aspects of our lives, from the way we walk and talk to the way that we both organise and get organised by our styles. The rhythms that we embody and express are shaped by our material, biological, and sociohistorical environments, as well as the different visible and intelligible styles that we inhabit. The rhythms of the material, biological, and sociohistorical world allow for a resonance of styles that synchronises our styles with those around us.

2.3 Summary and Context

In summary, style is the visible and intelligible expression of what we are, as well as the sociohistorical world that both shapes and gets shaped by the norms, ideas, concepts, values, beliefs, traditions, and cultural practices that we both create and get created by. This is Nishida and Noë's world of action and organisation, where we both organise and get organised by our activities. Style is an unfolding aesthetic phenomenon that cannot be reduced to mere material and biological processes alone, like entrainment and ORDER systems. While the sociohistorical world, like the material and biological realms, is in a

constant state of transformation, the transformation and evolution of styles is an unfolding aesthetic question that resists contemporary scientific analysis and categorisation.

However, while distinct, ORDER and style are entangled. Style loops down and resonates within the rhythms of the material and biological world, giving rise to periods of emergent synchronisation and organisation. ORDER systems also loop up and resonate with styles that we inhabit. ORDER, therefore, is not a metaphor or analogy for how our styles are entangled, but rather an underlying and fundamental process that helps shape what we are.

In context, Noë's concept of style, situated within the aesthetic paradigm, is an unfolding aesthetic phenomenon that cannot be reduced to mere material and biological processes. Noë's framework suggests that ORDER and style are entangled, resonating with each other and the sociohistorical world in which both are embedded. Entrainment provides a foundation for the emergent synchronisation and organisation between humans and their environment, including other people. It is through our existential and embodied styles that these structures of organisation are given meaning, resonating within the ever-changing sociohistorical world in which they are entangled. Therefore, the entanglement of ORDER and style both 'shapes what we are [and] shapes the world that in turn shapes us.'[696]

Section 3: Entrainment as a Tool

Having discussed the entanglement of ORDER and style, let us now turn our attention to art, specifically to how artists can intentionally use spontaneous entrainment to shape the organised activities which, in turn, shape our style. In Chapter 3, Section 3.3, Demos et al. made a purported distinction between spontaneous and intentional entrainment, claiming that '[p]articipants in the spontaneous and intentional conditions were affected in similar ways by the music; […] the intentional condition exhibited more entrainment with the music […]

[696] Maraldo (2017). *Japanese Philosophy in the Making*. p.199.

above chance levels.'[697] Implicit in this is the assumption that for humans, as Repp previously explained, entrainment 'is normally an intentional activity.'[698] While synchronisation can emerge spontaneously and unintentionally, it can be inhibited and stopped by intention. For this reason, Demos et al. and Repp assert that there can be intentional and spontaneous entrainment, and that the former supersedes the latter. This is incorrect. Intention, whether it be shared or individual, planned, or enacted, is something other than entrainment.

3.1 Intentional Synchronisation Is Not Spontaneous Entrainment

Entrainment is a spontaneous phenomenon. It is a period of spontaneous and emergent synchronisation initiated and sustained by the transfer of energy between open systems. In the sociohistorical world, the world of *kōiteki chokkan*, organised activities, and of existential style, spontaneous entrainment involves acting in a non-deliberative and pre-reflective way. This was exemplified when pedestrians spontaneously walked in sync crossing the Millennium Bridge, and when a new DN cycle spontaneously "pulls up" our circadian rhythms. In Cirelli et al.'s study,[699] this occurred when the neural oscillations of infants spontaneously synchronised with the frequency of perceived rhythmic stimuli and, in Nazzi et al.'s experiments,[700] when infants spontaneously covocalised with their caregivers.

Intention is not a spontaneous phenomenon. It requires deliberation and reflection, in the sense that intention is a future-orientated decision, plan, or commitment to act or to stop acting in a certain way. In Walter et al.'s study on 'Cortical Phase Synchronization While Playing Guitar,'[701] the observed synchronisation between guitarists' brains did not provide evidence of entrainment, contrary to Walter et al.'s conclusion. In these experiments, both guitarists were entrained with the same metronome in the preparatory period and thus

[697] Demos et al. (2010). *Spontaneous Vs Intentional Entrainment*. p.4.
[698] Repp (2005). *Sensorimotor Synchronization: A Review*. p.970.
[699] Cirelli et al. (2016). *Measuring Neural Entrainment to Beat and Meter in Infants*. Title.
[700] Harder et al. (2015). *A Longitudinal Study of Coordination in Mother-infant Vocal Interaction*. Title.
[701] Walter et al. (2009). *Brains Swinging in Concert*. pp.1 - 12.

individually synchronised with it. Once the metronome stopped, their synchronisation with each other may have been intentionally sustained during their joint performance. This can also explain the observed decrease in brain synchronisation as both guitarists continued to play. While both guitarists were spontaneously entrained with the metronome, their joint performance involved elements of intentional synchronisation. Thus, both brains were spontaneously entrained with the rhythmic stimuli of the metronome, not with each other.

Nazzi et al.'s experiments looking at covocalising between infants and their caregivers further exemplifies how intention, in this case that of caregivers, is different from spontaneous entrainment. In these experiments, caregivers did not spontaneously entrain with infants' vocalisations, instead providing rhythmic stimuli to which the infants spontaneously entrained. Caregivers intentionally, even if only tacitly, refused to entrain with infants in order to provide the rhythm of language. Similarly, in tapping studies, spontaneous entrainment occurs when participants intuitively find and keep a beat. At lower tempos, intention can interfere with the ability to keep a beat, as deliberation and reflection about every tap of a finger impedes the ability. Therefore, spontaneous entrainment emerges when the perceived rhythms around us "pull up" or "pull down," and thus organise, our activities.

In interpersonal studies, the role of intention is more pronounced. Dancing in groups, for example, involves a complex interplay of spontaneous entrainment and intentional synchronisation. Dancers spontaneously entrain with the music as well as each other while often intentionally synchronising their movements, as exemplified in Van Dyck et al.'s dancing study where participants in the same group seemed to intentionally match their movements with greater synchronisation compared to other group.[702] Therefore, intentional synchronisation ends where spontaneous entrainment begins; intention and spontaneity are antithetical.

[702] Van Dyck et al. (2013). *The Impact of the Bass Drum on Human Dance Movement*. p.357.

3.2 Intentional Spontaneous Entrainment

While distinct, intention and entrainment are entangled. Entrainment is a tool that many people, especially artists, can intentionally use, even if they are unaware of the phenomenon itself. Musicians are often tacitly aware of this, intentionally using spontaneous entrainment as a tool to enhance their performances. By exploiting the natural capacity for spontaneous entrainment, musicians can intentionally play with an audience's expectations, essentially "pulling up" their experience in surprising and immersive ways. For example, electronic dance music (EDM) often involves gradually increasing the rhythmic tempo (the build-up), followed by a brief silence (the break), before an abrupt change in rhythm (the drop).[703] By using entrainment to manipulate expectations, EDM can heighten an audience's experience when the beat drops.

Similarly, Dance choreographers intentionally create works that resonate with audiences. While we can all perform dancing spontaneously, without planning or preparation, Dance requires explicit training, deliberation, planning, and intention. Dance is the intentional creation of a "tool" that aims to alter or affirm the organised activity of dancing. Choreographers create Dance routines that resonate with the natural rhythms of audiences and dancers. On one level, this spontaneously shapes how the audience performs dancing. On another level, it also spontaneously shapes the audience's understanding of dancing. This is unsurprising given the links between entrainment and learning discussed in Chapter 3, as spontaneous entrainment is often intentionally used by caregivers as a tool to teach the rhythms of language to infants. Likewise, Dance uses spontaneous entrainment to intentionally teach new ways of dancing, offering new ways of organisation. The intentional use of spontaneous entrainment by choreographers provides rhythms that audiences can

[703] Amelia Turrell, Andrea R. Halpern, and Javadi Amir-Homayoun (2019). When Tension is Exciting: An EEG Exploration of Excitement in Music, *bioRxiv; Cold Spring Harbor*. pp.1 – 19.

spontaneously entrain to, enhancing their experience and altering the organised activity of dancing.

The key distinction is that 'Dance […] puts dancing on the stage; it offers enactments or displays […] of dancing.'[704] A Dance performance intentionally reveals what dancing can be, using entrainment as a tool to influence how dancing is and can be spontaneously performed. This mutual determination between spontaneous dancing and intentional Dance exemplifies Noë's 'looping entanglement of art and life [where] Dance alters dancing and dancing informs Dance.'[705] Thus, while distinct, there is an interplay between intentional Dance and spontaneous dancing, with dancing being altered by Dance, just as Dance is informed by and contributes to dancing.

We act in a world that shapes how we act, in the sense that organised activities both include and transcend individual actions and intuitions. It is our shared sociohistorical existence, being partially shaped by the phenomenon of entrainment, that shapes and organises much of what we can and will do as individuals. Art, for Noë, offers liberation from the organised activities that dominate our lives. Artists 'make art out of organized activities,'[706] intentionally using spontaneous entrainment as a tool to allow us to break free from the many different and overlapping organised activities that dominate us. Art, for Nishida, can also affirm the organised activities that dominate our lives, with artists, once again, having the ability to intentionally use spontaneous entrainment in their creations. Intentional synchronisation is not spontaneous entrainment, and yet, in art, both are inextricably linked. This is the 'looping entanglement of art and life,'[707] wherein what the

[704] Noë (2021). *Entanglement and Ecstasy in Dance*. pp.64 – 65.
[705] Ibid. pp.63 – 67.
[706] Noë (2015). *Strange Tools*. p.10
[707] Noë (2021). *Entanglement and Ecstasy in Dance*. p.63.

artist intentionally creates can spontaneously shape organised activities which, in turn, spontaneously shapes what the artist intentionally creates.

3.3 Entrainment in the World of Action and Organisation

The entanglement of art, life, and entrainment permeates all aspects of our lives, shaping our style and what we are. As Noë explains, '[t]he things we know best, that make us what we are—our mental powers and personalities—are made up by art […]. We ourselves, then, are the very stuff of art. We are living in the entanglement.'[708] It is the entanglement of art, life, and entrainment that make us what we are. An organised activity, such as dancing, Noë continues, 'is spontaneous and "natural," but expressive of intelligence and sensitivity; it is typically social and serves all manner of communal functions (celebration, courting, etc.); dancing entrains what we do and how we move with characteristic and recognizable temporal and spatial dynamics.'[709] Thus understood, dancing is a matter of style, emerging as the visible and intelligible expression of what we are. Additionally, Noë continues, '[t]he existence of tools, technologies, and organized activities is art's precondition […]. Art does not aim at more tools, more technology, better organization. Instead, art *works with* these constitutive habitual dispositions; artists make art out of them.'[710] Art can affirm and iterate upon organised activities, such as dancing, with artists intentionally shaping our shared styles using tools like spontaneous entrainment.

However, while art is a creative activity, being linked to human tool use and '*making* activities,'[711] this is not its main function. Contrary to Carroll, Eaton, and Guyer's criticisms of Noë in Chapter 1, Section 5, Noë argues that art's main function extends beyond mere creative or making activities:

[708] Noë (2023). *The Entanglement.* p.8.
[709] Ibid. p.9.
[710] Ibid. p.9.
[711] Ibid. p.9.

> Artists make things not in order to surpass mere technology or manufacture, not because they can do it better or in a more "aesthetically pleasing" way. They make things, finally, because we are makers; that is, we are beings whose lives are given shape by the things we make and by the ways we find ourselves organized in good measure by things we have done or made. By making, and by exposing what our making takes for granted, art puts us on display. And it does so in ways that change us and, finally, liberate us from the bonds of habit and character.[712]

Noë is arguing here that art is not defined by its creative activities or the tools it uses, like entrainment. Art transcends these, engaging with and reshaping our existential style. In this way '[a]rt loops down and changes the life of which it is the artistic representation.'[713] This is the entanglement of art and life, where art provides a way to engage with the norms, concepts, values, beliefs, and practices that organise our lives and what we are.

In this context, the phenomenon of entrainment is a tool frequently utilised by artists, and plays a key role in making us what we are. Entrainment offers a way to transcend and shape our style. Defined as an ORDER system, entrainment spontaneously "pulls up" and "pulls down" our style, directly shaping and organising what we can and will do. Thus, spontaneous entrainment is a tool that art and artists can intentionally use, even if tacitly, to shape our style, reflecting and altering what we are.

3.4 Summary and Context

In summary, entrainment is the spontaneous and emergent synchronisation between open energy systems, initiated and sustained by shared ETM. In the sociohistorical world, entrainment involves intuitive and spontaneous actions. This is when perceived rhythms of the world spontaneously "pull up" or "pull down" our activities.

[712] Noë (2023). *The Entanglement*. p.11.
[713] Ibid. p.11.

Spontaneous entrainment is also a tool that artists can intentionally use. It can enhance a work of art, as exemplified by the way musicians manipulate audiences' natural tendency for entrainment, or how Dance artists create choreographed works that spontaneously resonate with both Dancers and audiences. On an existential level, the looping entanglement of art and life shows how entrainment spontaneously shapes our styles. Artists use entrainment to reshape the organised activities that shape our style.

In context, distinguishing between spontaneous entrainment, intentional synchronisation, and intentional spontaneous entrainment helps us to further understand Nishida and Noë's world of action and organisation. In this world, being the world of organised activities, action, and style, spontaneous entrainment evokes intuitive and non-deliberative actions, while also serving as a tool that artists can intentionally use to reshape the organised activities that shape our style.

From birth, we are caught up in these structures of organisation, whether we are aware of them or not. Our lives are organised by processes that both include and transcend us, shaping and organising much of what we can and will do, as well as what we are. Artists are often intuitively aware of this, intentionally using spontaneous entrainment as a tool to investigate and shape the organised activities from which they are informed.

Conclusion

In conclusion, this chapter has explained the entanglement of art, life, and entrainment. Using Nishida's philosophy of science, bolstered by Noë's aesthetic paradigm, it has provided a foundation for understanding this complex entanglement. In the material, biological, and sociohistorical world, we are entangled in a complex web of ORDER and style, where we resonate with each other as well as within organised activities in which they are embedded. Our existential style, grounded in the phenomenon of entrainment, resonates

with and in the sociohistorical world. This is something that artists are often aware of, even if only intuitively, when they intentionally use entrainment as a tool to spontaneously investigate and shape organised activities.

While spontaneous entrainment and intentional synchronisation were shown to be distinct, both are entangled within the material, biological, and sociohistorical world. This world of action and organisation involves spontaneity, intuition, and non-deliberative actions, all of which are entangled with intentional and deliberative actions. These structures of organisation are an integral and inescapable part of what it is to be human. Whether we know it or not, our lives are shaped and organised by spontaneous and intentional process that both include and transcend us, shaping and organising what we can do and what we are.

This reaches far beyond art. In Chapter 2, spontaneous entrainment was identified as a ubiquitous phenomenon in the material, biological, and sociohistorical world. In Chapter 3, neural entrainment and CFC between neural oscillations was identified, as was sensorineural entrainment between our brains and SNS with the perceived stimuli around us. Acoustic rhythms, such as language, singing, music, and so on, were shown to spontaneously "pull up" our neurobiology. Optical rhythms, such as the day-night cycle, flashing lights, written words, and even other people, were all shown to initiate and sustain periods of emergent synchronisation. These examples, among many others, show how entrainment can spontaneously shape our styles, with or without artists intentionally using it as a tool.

Therefore, entrainment is far more than a metaphor. It is a powerful force that resonates with and in the entanglement of art and life, intentionally and spontaneously organising and transforming the sociohistorical world and the styles that we inhabit. In short, entrainment helps make us what we are: an aesthetic phenomenon.

Chapter 5: Conclusion, Implications, and Future Research

5.1 Conclusion

In conclusion, this dissertation has argued, through a comparative analysis of Nishida and Noë, that art, life, and entrainment are entangled, and that this entanglement shapes what we are: an aesthetic phenomenon. In Chapter 1, the first research question was addressed by showing where Nishida and Noë agree and, more importantly, disagree about art and its place in our lives. Both thinkers were shown to share a comparable understanding of art, agreeing that artistic actions and intuitions shape and organise the world which, in turn, shapes and organises artistic actions and intuitions. While they disagree at times, most notably about the role of the artist in the creative process, the integration of Nishida and Noë's perspectives created a more robust theory of art, showing that art can have a myriad of different functions, both strange and ordinary. Labelled as the world of action and organisation, this chapter concluded by highlighting the need for a more grounded investigation into the potential mechanisms underlying Nishida and Noë's shared understanding of art.

In Chapters 2 and 3, the second research question was addressed when entrainment provided a concrete explanation for Nishida and Noë's world of action and organisation. Defined as an ORDER system, entrainment in the material, biological, and sociohistorical world demonstrated how, like pendula, starlings, and bridges, humans transfer and absorb energy from a world that, in turn, transfers and absorbs energy from us, thus giving rise to period of emergent synchronisation and organisation. In Chapter 3, neuroecological entrainment provided a further explanation for Nishida and Noë's world of action and organisation, only this time with a focus on human brains, sensorineural systems, sensorimotor systems, and the rhythmic stimuli of our environments. After looking at several

neurobiological studies, tapping studies, movement studies, and interpersonal studies, all of which exemplify ORDER system where parts "pull down" the behaviour of the whole which, in turn, "pulls up" the behaviour of its parts, this chapter concluded by highlighting the limitations of current scientific paradigms. This was particularly evident in those studies involving interpersonal and intentional synchronisation.

Finally, in Chapter 4, the third research question was addressed by an exploration of how Nishida and Noë might respond to the use of entrainment as an explanatory tool, thereby highlighting its limitations as such. Nishida's underdeveloped philosophy of science, as a response to positivism, was supported by Noë's aesthetic paradigm in the context of style, highlighting the importance of intention in studies on entrainment. To do this, a distinction was made between spontaneous entrainment, intentional synchronisation, and intentional spontaneous entrainment. In the sociohistorical world, the world of action and organisation, spontaneous entrainment involves acting intuitively, in a non-deliberative and pre-reflective way. Intentional synchronisation, in contrast, involves acting deliberately, synchronising our actions with perceived stimuli, including other people. Artists are often intuitively aware of this, intentionally using spontaneous entrainment to shape the world of action and organised in which we are entangled, ultimately shaping what we are. Therefore, the central thesis of this chapter, and of the dissertation as a whole, is that art, life, and entrainment are entangled, and that this entanglement shapes what we are: an aesthetic phenomenon.

5.2 Implications

5.2.1 Enacted Cognition

For Nishida, art is a paradigm example of *kōiteki chokkan*, a recognisably enactivist theory. Intuition is not the representation of a pregiven world by a preexisting mind, but rather the enactment of an active and embodied mind and world. Nishida recognises that art

shapes the world as much as the world is shaped by it, suggesting that the cognitive processes of the artist are enacted by their activities in and with the world. Only very recently has Noë, and even more recently Miriam Kyselo, started to recognise the importance of art in this context. Therefore, the integration of Nishida and Noë's theories opens up new avenues of discussion in both philosophy and cognitive science.

Entrainment, a well-studied phenomenon in science, is well situated to facilitate such dialogues. It provides a concrete mechanism for scientists to understand Nishida and Noë's philosophies, as do Nishida and Noë highlight the limitations of contemporary scientific studies looking at entrainment. By incorporating empirical examples of entrainment, it can be demonstrated how art and world are co-constitutive, enriching our philosophical and scientific understanding of enacted cognition. This dialogue is to the benefit of all, as it advances our understanding of enacted cognition by recognising the importance of intention, while also recognising how our styles are enacted and cultivated by art.

To further advance these discussions, theories of enacted cognition should also consider the phenomenon of entrainment. Similar to Varela et al., who write that 'cognition is not the representation of a pregiven world by a pregiven mind but is rather the enactment of a world and a mind,'[714] neuroecological entrainment shows how cognitive processes synchronise with the rhythmic stimuli of the world. When caught up in an ORDER system, our brains, bodies, and behaviours shape and get shaped by our environment, demonstrating the enactment of both mind and world. Integrating entrainment into theories of enacted cognition can further enhance our understanding of the reciprocity between mind and world, while also recognising how art is a paradigm example.

[714] Varela et al. (1991). *The Embodied Mind*. p.9.

5.2.2 Hard and Soft Positivism in Science

This dissertation has argued that entrainment can help us understand and explain Nishida and Noë's world of action and organisation, but only to a point. It has highlighted how, within the sociohistorical world, entrainment extends beyond traditional positivist paradigms in science, demanding a new paradigm that is capable of engaging with the complexities of subjectivity. The question then arises: can science remain committed to objectivity while still meaningfully engaging with the sociohistorical world and the subjectivity that it entails? This dissertation's contribution is to argue that it can, specifically by adopting a less rigid positivist paradigm. Borrowing from an analogous distinction in legal theory, one way to articulate this new paradigm is through a distinction between *hard positivism* and *soft positivism* in science.

In jurisprudence, *hard positivism* (also known as *exclusive positivism*) is the idea that legal institutions should strive for objectivity by excluding or accounting for all other forms of influence. This position is grounded in the idea that, as Jules L. Coleman explains, it is 'part of the project of jurisprudence to be determining the criteria that set law apart from other modes of regulating human affairs, for example, moral rules, informal norms, sanctioning and pricing systems.'[715] This is why, for example, many legal institutions begin with the presumption of innocence, as it is thought to preserve neutrality in legal reasoning by excluding social, political, and moral influences. Put simply, hard positivism in jurisprudence aims for objectivity by excluding the influence of subjectivity.

In contrast, *soft positivism* (also known as *inclusive positivism*) is the idea that, in certain cases, other considerations can be included as part of determining the existence and validity of laws.[716] Think of how, for example, international law is often grounded in legal

[715] Jules L. Coleman (2009). Beyond Inclusive Legal Positivism, *Ratio Juris*. 22(3), p.361.
[716] Coleman (2009). *Beyond Inclusive Legal Positivism*. p.361 – 362.

norms and broader moral principles, including universal human rights, crimes against humanity, genocide, and the idea of cruel and unusual punishment. While it is a fallacy to equate morality and legality, soft positivism in jurisprudence aims for objectivity while, in some cases, allowing for other non-legal considerations.

Although jurisprudence and science are distinct disciplines, a similar distinction can be made between hard and soft positivism in science. In the context of science, hard positivism is the idea that knowledge about reality can *only* be gained by way of observation or logical analysis. This is the traditional positivist paradigm discussed in Chapter 4, where subjectivity is deemed antithetical to the purported objectivity of science. Accordingly, other considerations, such as value statements about aesthetics and morality, are all deemed to have no place in science, as they involve subjectivity and, consequently, are not empirically verifiable. Thus, hard positivism in science is the position that scientists should aim for objectivity by excluding or controlling for subjectivity.

Soft positivism in science, as proposed here, is the view that science can still aim for objectivity while also, in certain cases, including other considerations. While this term originates in legal theory, it is adopted here because its structure, particularly its ability to maintain objectivity while also accommodating for normative considerations, creates a novel framework for integrating science with other metaphysical considerations including, but not limited to, subjectivity. For example, in studies looking at interpersonal entrainment when dancing, a hard positivist would focus on the measured emergent synchronization between participants while excluding the role of intention and other more complex social dynamics. A soft positivist, in contrast, would integrate both, measuring the emergent synchronization between dancers and, for instance, incorporating qualitative data from "intention reports." By including and equally prioritising quantitative and qualitative data, researchers can determine when participants were spontaneously and intentionally synchronising their movements. In

this example, subjectivity can be included without abandoning objectivity, as both have an explanatory power that, when combined, offers a more robust and nuanced understanding of how and why people dance in synchronization. Thus, soft positivism advocates for the integration science and other metaphysical considerations, including, but not limited to, those concerning subjectivity and consciousness.

Daniel Dennett calls this kind of integration in science *heterophenomenology*, arguing that scientists and philosophers should take 'an explicitly *third*-person approach to human consciousness,'[717] and later adding that they should also 'take the *first* person point of view as seriously as it can be taken.'[718] For Dennett, this methodology treats subjective reports about consciousness as equally important data, albeit within what he deems a "fictional framework." This framework is fictional in the sense that researchers do not have access to participants' subjectivity, and yet they can still integrate these reports into objective methods by presuming the existence of subjective phenomenal experience. Many other thinkers in the philosophy of mind and consciousness, such as Evan Thompson, Francisco Varela, and Humberto R. Maturana,[719] have endorsed a similar integration of phenomenology and cognitive science, as have Kevin O'Regan and Alva Noë implicitly in their seminal paper, 'A Sensorimotor Account of Vision and Visual Consciousness.'[720] However, to reiterate, soft positivism is about much more than subjectivity and consciousness. While, as a methodology, it is well situated to address such questions, soft positivism advocates for a much broader integration of philosophy and science, as well as the natural with the social sciences. This new paradigm can incorporate many other metaphysical considerations, including, but not limited to, those concerning subjectivity and consciousness. Specifically, soft positivism

[717] Daniel C. Dennett (2003). Who's On First? Heterophenomenology Explained, *Journal of Consciousness Studies*.10(0), p.1.
[718] Dennett (2003). *Who's On First?* p.1.
[719] Varela et al. (1991). *The Embodied Mind*; Maturana, and Varela (1992). *The Tree of Knowledge;* and Thompson (2010). *Mind in Life.*
[720] O'Regan, and Noë (2001). *A Sensorimotor Account of Vision and Visual Consciousness*.

allows researchers to examine phenomena that are entangled within the material, biological, and sociohistorical world.

Traces of soft positivism can already be identified in contemporary science, as exemplified by the fact that many of the previous studies on neuroecological entrainment have incorporated elements of qualitative data. For example, when examining the potential links between cortical thickness and pain sensitivity among *Zen* meditators in Chapter 3, Section 3.2.2, Grant et al.[721] asked participants to rate their subjective feeling of pain. Similarly, when Hölzel et al.[722] investigated how mindfulness and breathing practices lead to increased grey matter in the brain, participants were asked to fill out a questionnaire about how mindfulness and equanimity had improved in their daily lives.

However, despite the presence of qualitative measures in such studies, this data is rarely integrated into their core findings in a meaningful way. This is particularly evident in interpersonal studies, where qualitative data is typically used only as a way to acknowledge the limitations of the research. In the discussion sections, researchers are often quite happy to speculate and philosophise about other considerations, such as the role and nature of intention, subjectivity, social dynamics, and many other "metaphysical" questions. However, from the perspective of soft positivism, such considerations are not merely an add-on; they are a fundamental and integral part of actually doing science. They should be integrated from the start, helping to shape the formulation of scientific research questions, methodologies, interpretations of data, and so on.

To their credit, it was only Demos et al.[723] who gave equal credence to quantitative and qualitative data when investigating spontaneous and intentional entrainment. Although, while this approach appeared promising at first, it was ultimately undermined by their

[721] Grant et al. (2010). *Cortical Thickness and Pain Sensitivity in Zen Meditators*. p.46.
[722] Hölzel et al. (2011). *Mindfulness Practice Leads to Increases in Regional Brain Gray Matter*. p.37.
[723] Demos et al. (2010). *Spontaneous Vs Intentional Entrainment*.

mistaken conflation of spontaneous entrainment and intentional synchronisation. Therefore, while traces of soft positivism can be identified in contemporary science, any prioritisation of quantitative data limits the depth of analysis and, importantly, only offers a partial understanding of neuroecological entrainment in the sociohistorical world.

Neuroecological entrainment is not merely a material or biological process, nor is it merely a social or historical one. It sits at the intersection of the material, biological, and sociohistorical world. Consequently, researchers interested in this phenomenon must adopt methodologies capable of accounting for its complexity, equally integrating quantitative and qualitative approaches. In short, they must adopt soft positivism.

To help understand, soft positivism can be contrasted with *postpositivism*, which posits that all of science is fallible and socially embedded, as it is always shaped by our conceptual frameworks and values. Ian Hacking, who is recognised as a postpositivist, makes this point in *Representing and Intervening*, concluding that '[l]ong-lived theoretical entities, which don't end up being manipulated, commonly turn out to have been wonderful mistakes.'[724] The reason for this, Hacking believes, is that human intervention in the world ultimately grounds scientific knowledge, rather than a presumed neutrality of observation or objectivity.

Although not explicitly a postpositivist, Noë's aesthetic paradigm aligns with Hacking on this point. Tellingly, Noë's 'looping entanglement of art and life'[725] is directly borrowed from Hacking's later work.[726] Like Hacking, Noë argues that science is a human activity and, consequently, is necessarily socially and culturally situated. Thus, for Hacking and Noë, as well as postpositivism more generally, true objectivity in science is impossible, as science

[724] Ian Hacking (1983). *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Britain; Cambridge University Press. p.275.
[725] Noë (2021). *Entanglement and Ecstasy in Dance*. p.63.
[726] Hacking (1995). *The Looping Effects of Human Kinds*.

entails subjectivity and is deeply entangled in society and culture. Where soft positivism is the view that science can still aim for objectivity while also including other considerations, postpositivism asserts that true objectivity in science is impossible.

Soft positivism can also be contrasted with *antipositivism*, what is sometimes referred to as *interpretivism*. This is the view that the sociohistorical world cannot be understood quantitatively or empirically. As Clemens Wieser explains, for the antipositivist, 'the meaning conveyed in social reality cannot be empirically observed because it is fundamentally abstract. To comprehend abstract social reality, empirical antipositivist researchers rely on qualitative methods.'[727] Antipositivists argue that true objectivity is impossible when examining social phenomena, as the sociohistorical world inherently includes subjectivity. This is why a purported distinction between first-order natural sciences and second-order social sciences is a core tenet of antipositivism. Similarly, in *The Blind Spot: Why Science Cannot Ignore Human Experience*, Adam Frank, Marcelo Gleiser, and Evan Thompson explain: 'science repeatedly shows us that our human situation is inescapable when we search for objective truth because we cannot step outside our human form.'[728] While not explicitly antipositivist, Frank et al. are saying here that any attempt to describe the world objectively is always mediated by our embodied, situated, and subjective perspectives. From this perspective, antipositivist research approaches, such as hermeneutics and phenomenology, assert that the social sciences are a second-order interpretation of the world, with the empiricism and observation of the natural sciences being a first-order and insufficient way to describe and explain social phenomena.

[727] Clemens Wieser (2013). Positivism, Antipositivism, and Empiricism, In – James Ainsworth, ed. (2013). *Sociology of Education : An A-to-Z Guide, Volume 2*. California; SAGE Publications, Inc. p.983.
[728] Adam Frank, Marcelo Gleiser and Evan Thompson (2024). *The Blind Spot: Why Science Cannot Ignore Human Experience.* The MIT Press. p.viii.

Antipositivism resonates with Nishida's philosophy of science in Chapter 2, Section 1.2, where his concept of "interexpression" provides a way of understanding the ambiguity and interplay between subjectivity and objectivity in both science and art. Like antipositivism, Nishida rejects positivist paradigms, recognising the importance of subjectivity. Wieser explains that '[a]ntipositivists reject the philosophical assumptions of empiricism applied in natural sciences and argue that social reality is fundamentally different from physical reality.'[729] Accordingly, for both Nishida and the antipositivist, the social sciences necessarily entail subjectivity and, consequently, there can be no true objectivity when examining the sociohistorical world. However, while there are similarities, antipositivism does not take as extreme an approach as Nishida, who, as we saw, seems to be suggesting that subjectivity quite literally shapes the objective world. Instead, antipositivism explicitly rejects the idea of true objectivity in science, especially within those disciplines that include subjectivity.

In contrast to postpositivism and antipositivism, the soft positivism endorsed here retains a commitment to objectivity in science while acknowledging that, in specific cases, other considerations are necessary for making certain phenomena intelligible. Soft positivism differs from postpositivism's inclination to treat objectivity as irretrievably compromised or, at the very least, provisional. Soft positivism also differs from antipositivism. While it does recognise the importance of subjectivity, soft positivism also allows for the integration of the natural and social sciences, as well as metaphysical considerations. Rather than abandoning objectivity, soft positivism treats it as a necessary (if imperfect) aim for science, while also recognising that certain aspects of the sociohistorical world require the inclusion of other kinds of considerations to produce meaningful and explanatorily adequate accounts. Soft positivism in science can thus be understood as the idea that knowledge about reality can

[729] Wieser (2013). *Positivism, Antipositivism, and Empiricism*. p.983.

indeed be gained by way of observation or logical analysis, while acknowledging that, in certain cases, knowledge can also be gained by incorporating other considerations, such as subjectivity in the form of first-person reports, focus groups, interviews, participant observation, and similar qualitative methods.

As repeatedly shown throughout this dissertation, ignoring or omitting the role of subjectivity when investigating phenomena in the sociohistorical world ignores the very thing that makes these phenomena intelligible. When investigating the phenomenon of entrainment, considerations such as intention, social dynamics, and subjectivity can all enhance research questions, methodologies, and interpretations of data. By determining when such considerations are warranted, soft positivism maintains a degree of objectivity, while also acknowledging the limitations of current positivist paradigms.

The relevance of soft positivism was clearly evidenced in the discussion of style and ORDER in Chapter 4, Section 2. Within the sociohistorical, style was shown to loop down and resonate within the ORDER systems of the material and biological world which, in turn, loop up and resonate with the styles that we inhabit within the sociohistorical world. In articulating this, and understanding it as an instantiation of soft positivism, this dissertation has advanced beyond Noë's aesthetic paradigm and Nishida's tentative philosophy of science, as well as the closely related postpositivist and antipositivist paradigms. Instead, soft positivism offers a way to integrate material, biological, and sociohistorical processes in science while still maintaining a degree of objectivity. Adopting soft positivism in future studies can offer a more nuanced approach by integrating the social and natural sciences, particularly in those studies involving subjectivity.

The hard positivist might object, arguing that soft positivism undermines scientific rigor by including subjective consideration. However, soft positivism is not the uncritical

inclusion of personal biases, but rather the deliberate and transparent inclusion of subjective data, such as qualitative surveys and intention reports, where relevant. The antipositivist might also argue that soft positivism remains committed to an objectivity that can never be truly attained. However, soft positivism does not strive for pure objectivity, as it simply acknowledges that the inclusion of subjectivity is necessary for understanding certain phenomena. Finally, unlike antipositivism, soft positivism does not treat the natural sciences as first-order and the social sciences as second-order, but instead retains the empirical tools of the natural sciences for studying phenomena situated within the material, biological, and sociohistorical world.

In summary, this dissertation has demonstrated that soft positivism provides a methodology for integrating objectivity and subjectivity into scientific inquiry. Rather than treating subjectivity as antithetical to science, or conceding that true objectivity is unattainable, soft positivism asserts that objectivity remains a necessary goal, while also recognising that, in certain cases, subjectivity is an equally indispensable component. Although the dissertation is not intended to be an argument for soft positivism *per se*, it has demonstrated that this is a viable stance which has explanatorily and conceptually useful consequences. This offers a more robust approach to scientific inquiry, particularly for those studies investigating the sociohistorical world. Soft positivism recognises that the social and natural sciences are both complementary and necessary, capable of providing a richer understanding of complex phenomena that neither approach can fully capture on its own. By situating itself between hard positivism, postpositivism, and antipositivism, soft positivism is a methodology capable of accounting for the complexities of material, biological, and sociohistorical phenomena such as neuroecological entrainment.

3. Future Research

3.1 Daoism 道教

Founded in classical Chinese thought, Daoism offers a novel avenue for researching theories of enacted cognition. Enactivism is typically associated with Buddhism, specifically the *Mahāyāna* School, which includes *Jōdo Shinshū* 浄土真宗 (True Pure Land) and *Chan* or *Zen* 禪 (Meditation), both of which Nishida was intimately familiar with.[730] However, Daoism also recognises the "situatedness" of humans and the importance of environmental structuring, emphasising spontaneity and natural harmony both with and in the world.

Central to Daoist metaphysics is *wu* 无 (emptiness, or non-being), the generative potential that enacts *you* 有 (presence, or being). This is clearly elucidated in the Daoist "wheel and hub" analogy, as Hans-Georg Moeller explains:

> Whereas the spokes turn around within the wheel, the hub always stands still. Unchanged, it keeps its position and it does this simply by doing nothing. But this nonaction allows for the "action" of the spokes: it allows them to turn around in a regular and harmonious way. The stillness of the hub is the "source" for the orderly movement of the spokes.[731]

In this analogy, *wu* is not a passive absence but the source of action, as it the emptiness and stillness at the centre of the wheel that allows for movement. It is the *wu* of the hub from which the potential actions of the wheel arise.

Importantly, *wu* is not merely an absence, but rather the "source" or precondition from which *you*, action, and all phenomena arise. This is also true of the surrounding

[730] Nishida's mother, Nishida Tosa 土佐西田, was a follower of True Pure Land Buddhism, and Nishida became increasing interested in Buddhism later in life.
[731] Hans-Georg Moeller (2004). *Daoism Explained: From the Dream of the Butterfly to the Fishnet Allegory.* Chicago and La Salle, Illinois; Open Court. p.29.

environment in which the wheel is situated, as *wu* remains a metaphysical necessity for the existence of the wheel as well as any potential movements. In this way, Moeller continues, 'the Dao is like a wheel, it is […] less a foundation or a principle for things or beings than a structure or a pattern of happenings.'[732] In other words, Daoist metaphysics recognise the importance of environmental structuring, while also acknowledging the metaphysical necessity of *wu* as a generative potential for *you*.

Contemporary enactivist theories, however, primarily focus on the *you*, specifically on how the presence of a mind, body, and world generate action and cognition. While valid, this overlooks the generative potential of *wu*, which from a Daoist perspective is equally important.

For example, the Daoist concept of *wu wei* 無為 (effortless action) is to act in a spontaneous, non-deliberative, and pre-reflective manner. *Wu wei* is not necessarily the absence of action (although it can be), as it involves acting in a context-dependent and environmentally led way. Like the emptiness at the hub of a wheel, it is from *wu wei* that more deliberative action arises. Simply put, *wu wei* is to act in harmony with the structure of a world that includes *you* and *wu*.

In tapping studies, for instance, *wu wei* is to spontaneously tap a finger in synchronisation with a perceived stimuli. Rather than deliberating and reflecting on each movement, the phenomenon of neuroecological entrainment allows participants to find and keep a beat in a spontaneous and environmentally led way. Tapping studies can thus be said to exemplify *wu wei*, as spontaneous synchronization with a beat requires not deliberating and reflecting on each movement. As shown in Chapter 4, intention, whatever it entails, is something other than spontaneous entrainment. In fact, overthinking can at times disrupt our

[732] Moeller (2004). *Daoism Explained.* p.27.

ability for spontaneous entrainment, mirroring Daoist claims that *wu wei* can evoke harmonious action. Deliberating and reflecting on each individual movement impedes the ability to find and keep a beat, suggesting that entrainment is a more spontaneous, harmonious, and "perfect" way of acting than intentional synchronization. While a substantial topic, the relevant point here is that studies of neuroecological entrainment are, in part, also investigating *wu wei*. These studies are measuring people's ability to act spontaneously and without deliberation within the structure provided by their environments, whether it be the *you* and *wu* of a perceived rhythm, of a tapping finger, or, more generally, the actions afforded by emptiness.

The similarities between *wu wei* and neuroecologcial entrainment are further exemplified by the fact that, as shown in Chapter 4, entrainment is a spontaneous phenomenon. Because of this, research on entrainment can also potentially contribute to debates in Daoist philosophy concerning whether *wu wei* is "nonaction" or "action by nonaction" (*wei-wu-wei*), the latter being a skilful activity. In the *Zhuangzi*, for example, the inner and outer chapters apparently present differing views, leading to ongoing debates about whether *wu wei* is innate and effortless "flow state" or an acquired and skilful activity.[733] Edward Slingerland offers an explanation:

> To begin with, wu-wei was probably just coming into use as a technical term of art around the time that the Inner Chapters were composed, but by the time that the Outer and Miscellaneous Chapters were put together it had become a very established and popular term of art. Secondly, our borrowing of wu-wei as a term to describe [the

[733] Nathaniel F. Barrett (2011). Wuwei and Flow: Comparative Reflections on Spirituality, Transcendence, and Skill in the Zhuangzi, *Philosophy East and West*. 61(4), pp.679 – 706. See also - David Loy (1985) Wei-Wu-Wei: Nondual Action, *Philosophy East and West*. 35(1), pp.73 – 86.

> Inner Chapters] represents a venerable practice begun by the writers of the Outer and Miscellaneous Chapters of the *Zhuangzi*.[734]

In other words, the apparent tension between the Inner and Outer Chapters may, in part, be a product of the historical development and changing usage of the term, with more recent interpretations being attributed to the inner chapters retrospectively. Nevertheless, beyond the *Zhuangzi*, Slingerland explains, 'wu-wei has built into it a productive tension (the "paradox of wu-wei") that […] arises from the fact that the state of effortless, perfected action represented by wu-wei is portrayed as a state that needs to be achieved.'[735] Thus understood, *wu wei* is paradoxically an innate and effortless action, yet also acquired and skilful activity.

Neuroecological entrainment, understood as an instantiation of *wu wei*, provides a potential response. Like *wu wei*, neuroecological entrainment is something that can be performed spontaneously and, as shown in Chapter 3, is also an activity that can be improved and refined through practice. This highlights that neuroecological entrainment is an innate *and* skilful activity, thus indicating that the *wu wei* articulated in inner and outer chapters of the *Zhuangzi* may in fact be consistent.

This is not to suggest that *wu wei* and neuroecologcial entrainment are exactly the same phenomenon. *Wu wei* is a much broader concept. It has, among many others, implications regarding social and political action, as well as ethical connotations, whereas entrainment does not. It is also important to note that there is no universally agreed upon interpretation of *wu wei,* as it is often understood in different ways depending on the text, both inside and outside the Daoist tradition.[736] Nevertheless, studies of neuroecological entrainment are still, in part, exploring the phenomenon of *wu wei*, offering exciting avenues

[734] Edward Slingerland (2000). Effortless Action: The Chinese Spiritual Ideal of Wu-wei, *Journal of the American Academy of Religion*. 68(2), p.308.
[735] Slingerland (2000). *Effortless Action: The Chinese Spiritual Ideal of Wu-wei*. p.298.
[736] Loy (1985) *Wei-Wu-Wei: Nondual Action*. pp.73 – 86.

for the development of a "science of *wu wei*" that can recognise the importance of environmental structuring and how *wu* relates to the enactment of action, perception, and cognition.

This dissertation has argued that art, life, and entrainment are entangled, and that this entanglement shapes what we are: an aesthetic phenomenon. Paradigmatically exemplified in art, Nishida and Noë's world of action and organisation is such that action shapes and organises a world which, in turn, shapes and organises action. Accordingly, for both thinkers, environmental structuring is a necessary component for action and intuition. However, while *wu* is implicit, the main focus of this dissertation has been on *you*, specifically on the presence of mind and body as they are situated within the material, biological, and sociohistorical world. Further research could integrate Nishida and Noë's world of action and organisation with Daoist metaphysics, specifically the concept of *wu* and how this is the generative potential which enacts *you*.

Given the similarities between *wu wei* and neuroecological entrainment, art offers a potential way to do this. This is because *wu wei* is paradigmatically exemplified in many artistic practices, such as Noë's capital-D Dance, as well as being a paradigm example of the world of action and organisation. When creating and performing Dance, artists often describe entering states of spontaneous creativity where action emerges intuitively in response to the environment rather than by way of explicit deliberation or reflection. As shown, Dance and dancing involve acting in harmony with the material, biological, and sociohistorical world, as what is and can be performed is shaped by the complex interplay of physical, biological, and social influences. Both dancing and Dance are activities that we all can do, which require no necessary level of skill, but which can nevertheless be cultivated through repetition and practice. In short, dancing and Dance are forms of effortless yet skilful action.

Future research could also examine whether neuroecological entrainment and artistic practices extend to other embodied activities traditionally associated with *wu wei*, such as painting or calligraphy. These artistic activities also rely on a cultivated and intuitive sensitivity to environmental affordances, where skilful actions emerge spontaneously from the structure of a given situation. Future work could investigate whether spontaneous entrainment (innate) and practised refinement (skilled) share underlying mechanisms, thus exploring how activities involving neuroecological entrainment can explicate how *wu wei* functions as both an innate capacity and a cultivated skill.

Accordingly, many forms of art can be understood as both a skilful and a spontaneous activity, where artists train to become sensitive to the structure of their environments so that their actions emerge naturally, spontaneously, and intuitively in response. This offers a clear instantiation of *wu wei*, and suggests that further research into artistic practice could provide empirical and philosophical insight into how spontaneous and effortless action emerges from the interplay between skilful activity and environmental structuring, investigating how *wu* is the generative potential which enacts *you* within Nishida and Noë's world of action and organisation. This could further develop the entanglement of art, life, and entrainment, and how this entanglement shapes what we are: an aesthetic phenomenon.

3.2 Neo-Confucianism 宋明理學

Neo-Confucianism also offers a novel avenue for researching enacted cognition, specifically with regard to moral psychology and the importance of "ritual." A response to the Buddhist and Daoist hegemony in Ancient China, Neo-Confucianism posits a kind of "moral metaphysics" (*daode xingshangxue* 道德形上学) that recognises the "situatedness" of humans, while also emphasising a natural harmony within the world. Neo-Confucians perceive the world, or ultimate reality, as inherently moral, asserting that to act in harmony

with the world is to also act morally. Neo-Confucianism places an emphasis on moral development or cultivation, offering a situated and enacted form of moral psychology.

Within the Neo-Confucian tradition, central to moral cultivation is *li* 理 (rational, or ritual principle). Originally one of the Pre-Qin Confucian five virtues, Neo-Confucians during the Song and Ming dynasties (960-1644) would later develop *li* beyond mere ritual or rite. Thus understood, *li* is the intrinsic order of the cosmos.[737] It is a metaphysical descriptor for the structure and order of our environment, being instantiated in the heavens and on the earth.

Yat-hung Leung explains that '[t]he metaphysical aspect of the ultimate reality is about the ontological ground of existence, which concerns the nature and the normative status of things, instead of their physical formation.'[738] Put another way, Neo-Confucian metaphysics posits that the *li* or order of the cosmos is intrinsically moral, and that, consequently, living in harmonious accordance with *li* evokes moral cultivation. Zhang Zai 張載 (1020–1077), a seminal Neo-Confucian, explains this:

> Heaven is the father; Earth is the mother. And I, this tiny thing, dwell enfolded in Them. Hence, what fills Heaven and Earth is my body, and what rules Heaven and Earth is my nature. The people are my siblings, and all living things are my companions. […] All under Heaven who are tired, crippled, exhausted, sick, brotherless, childless, widows or widowers—all are my siblings who are helpless and have no one else to appeal to.[739]

[737] The Greek word "*kosmos*" itself means order.
[738] Yat-hung Leung (2023). Gratitude to the Ultimate Reality in Zhu Xi: A Case Suggesting how God can be a Fitting Target of Prepositional Gratitude, *Philosophia (Ramat Gan).* 51(3), p.1393.
[739] Zhang, Z., Bryan W. Van Norden, and Justin Tiwald, trans. (2014). The Western Inscription, In – Justin Tiwald and Bryan W. Van Norden, eds. (2014). *Readings in Later Chinese Philosophy*. Indianapolis: Hackett Publishing. p.135.

In other words, there is a metaphysical unity between individuals and the order of the cosmos, and it is *li* that allows us to harmonise with each other and our environment. By living in harmonious accordance with the moral order of cosmos, it is *li* that evokes moral cultivation.

It is important to note that, as Xie et al. explains, '*Li* not only refers to rituals and ceremonies, but also is a way of living and being, having multiple meaningful attributes, such as morality, order and practice.'[740] In other words, *li* is not imposed upon us, being some ritual, rite, or ceremony that we are simply obliged to follow. *Li* is as much a part of our moral psychology as it is a part of the heavens and the earth. We are moral beings situated in a moral environment, and it is *li* that allows us to cultivate and embody benevolence (the Confucian virtue *ren* 仁) within ourselves, toward others, and in the world around us. Like polishing a dusty mirror, the practices of *li* reveal and reflect the moral order of the cosmos already present within our moral psychology.

Li is particularly revealing when it comes to the idea of enacted cognition, as it highlights the potential importance of rituals and rites in the enactment of moral psychology. Given that enacted cognition is typically understood as the enactment of a mind and a world, *li* can be similarly understood as a set of embodied practices that instantiate and enact the moral order of the cosmos in our lives, thereby cultivating moral perception and action.

For example, when we take part in funeral rituals, these are far more than a mere social or cultural ceremony. When we experience the loss of a loved one, our grief and mourning are not prescribed by the rites and rituals of our society, but rather the rites and rituals of our society are the enactments of our grief. In this context, the Confucian tradition of three years of filial mourning, for instance, is not a mandatory prescription enforced on a

[740] Wei Xie, Yancui Zhang, Yue Wu, and Benyu Guo (2023). The significance of dynamic mind-body cultivation of Li—based on archetypal mind-body mutual shaping development theory, *Culture & Psychology*. 29(4), p.705.

child, but rather the natural and moral response to the loss of a parent. Mourning rituals, in this context, are far more than codified rules; they are manifestations of the *li* and the moral order of the cosmos on earth. Mourning rituals and rites serve to cultivate empathy and benevolence for ourselves and the bereaved, while also instantiating the *li* of the cosmos.

This is not to suggest that the Neo-Confucian tradition is in any way unified. In fact, there are many variations across different epochs, some of which differ in important and possibly revealing ways. Notably the *Cheng–Zhu School* 程朱理學, and how it responds to the *School of the Heart* 心學, also known as the *Lu-Wang School.* At the risk of sounding reductive, the *Cheng–Zhu* argues that *li* is part of a metaphysical structure that shapes and cultivates moral development. The *Lu-Wang School*, in contrast, places a greater emphasis on the intrinsic moral knowing of our *xin* 心 (heart-mind), asserting that moral understanding primarily arises through the introspection than external ritual and rites. While *Cheng-Zhu* sees *li* as shaping morality through environmental structure, *Lu-Wang* prioritises the introspection of *xin*. Neo-confucianism can thus offer a unique avenue of research for enactivist theories, potentially providing an expanded theory of enacted moral psychology where *li* is instrumental in cultivating the moral order of the cosmos.

This dissertation has established that entrainment is a fundamental and pervasive phenomenon, showing how the structures and ORDER systems of our environment and neurobiology are inextricably linked. Entrainment provides order and organisation throughout the material, biological, and sociohistorical world, shaping much of what we can and will do. In this sense, like *li*, entrainment is the structuring order of our environment, being reflected in the heavens and on earth.

Within an entrained system, “rituals” can be understood, in part, as recurring, periodic, and rhythmic patterns of behaviour. Consider how, as discussed in Chapter 3,

Section 2.2.1, our circadian rhythm was shown to be far more than a habitual or conditioned response where we intentionally synchronise our lives with the rhythm of the DN cycle. Instead, our circadian rhythm involves material, biological, and social *zeitgebers* that "pull up" our biological and behavioural rhythms. In this context, morning rituals like waking up, washing, eating breakfast, drinking coffee, and so forth, are more than habitual routines. Similarly, bedtime rituals, such as limiting exposure to light, preparing a hot drink, reading, or meditative breathing, are responses that harmonise and entrain us with the order of the DN cycle. These rituals are far more than habit. They are the embodied expression of neurobiological entertainment, where our behaviour is spontaneously shaped by the DN cycle, while also being reinforced by social cycles and intentional synchronization. This is why jet-lag is classified as a disorder or syndrome, as recovering is a process of re-entrainment, not merely our intentional synchronization with a new DN cycle.

This could also be extended to funeral rituals and rites. Mourning the loss of a loved one can be understood as a psychological state, but also as a kind of "existential jet-lag." Over time, we become neuroecologically entrained with the rhythms of a loved one's presence. The sound and rhythm of their voice, their cadence and walking style, their breathing, all are embodied expressions of their material, biological, and sociohistorical existence, offering rhythms to which our own generated and expressed rhythms can entrain. This is why mourning can leave us disorientated, causing anxiety, fatigue, and a general sense of unease, much like jet-lag. In this way, a funeral ritual or rite is not merely prescribed by society; rather, such rites and rituals are enactments of our grief and of how we were neuroecologically entrained to another person.

Building upon how this dissertation has established that entrainment is a fundamental and pervasive phenomenon that, as Nishida and Noë have shown, helps make us what we are, future research could engage with the debate between the *Cheng–Zhu* and *Lu-Wang* Schools

by utilising entrainment to evaluate whether ritual practices scaffold moral intuition differently from introspection. From the bottom up, introspection and moral practices allow us to recognise that we are moral beings situated in a moral environment. From the top down, the structure of our moral environment allows us to recognise that we are moral beings, thereby giving rise to introspection and moral practices. Entrainment provides a mechanism for how this "upward" and "downward" morality might actually take place, potentially elucidating how living in harmonious accordance with *li* can evoke moral cultivation. Future research could also explore how rituals can (re-)entrain bodily, social, and environmental rhythms in ways that can evoke moral cultivation while also scaffolding psychological states like grief. This would further develop the entanglement of life and entrainment, offering a novel and valuable perspective where our embodied and situated practices are not merely social conventions, but the very means through which we enact and sustain the moral structure of the cosmos in our lives.

3.3 Computational Theories of Mind and Artificial Intelligence

Computational Theories of Mind (CTM) and enactivism seem to be incompatible, to the extent that, as Tomasz Korbak explains, '[a]ccording to computationalism, cognition boils down to information processing. According to enactivism, cognition boils down to self-organization under a functional boundary.'[741] CTM, specifically *connectionism*, understands complex cognitive processes, such as information, in terms of connected units, what Franklin previously called 'a linear threshold device,'[742] where individual units, typically neurons, are activated based on their shared anatomy and electrical behaviour. Importantly, different approaches to Artificial Intelligence (AI) often emphasise the processing of *representations*,

[741] Tomasz Korbak (2021). Computational Enactivism Under the Free Energy Principle, *Synthese (Dordrecht)*. 198(3), pp.2743 – 2744.
[742] Franklin (1995). *Artificial Minds*. pp.124 – 128.

which seems to place a barrier or, at the very least, strong distinction between mind and world.

Enactivism, in contrast, rejects the idea that cognition is merely the byproduct of connected units. For the enactivist, cognition is not something that just happens between our ears; it is a continuous and embodied activity that arises from the mutual interplay of brain, body, and world. Integrating enactivism and AI offers unique avenues of research. It can recognise the need for embodiment and "situatedness" when developing AI. This approach would emphasise spontaneity and natural harmony with the world, as well as the integration of robotics.

This also applies to Daoist and Neo-Confucian metaphysics. Building upon the previous Daoist insights, AI research could benefit from recognising the importance of environmental structuring and the generative potential of *wu*. Whether it is information processing between connected units, self-organisation under a functional boundary, or an embodied system, CTM and enactivism are similar in their implicit prioritisation of *you*.

However, similar to how the movement of a wheel necessitates the emptiness or stillness of a hub, connected units also necessitate an emptiness between. Future AI research could develop systems attentive not solely to the *you* of computational inputs and outputs, but also to the *wu* of timing, gaps, and pauses between them.

For example, Large Language Models (LLMs) are typically programmed to always respond to prompts, generating texts that are statistically pertinent. In human conversation, however, meaning often arises from what is left unsaid. Humans frequently delay, withhold, or intentionally avoid responding. Humans also lie, withholding information for a myriad of different reasons. In natural spoken and written languages, the pauses, hesitations, and

silences between words are equally as important as what is articulated. Like the sound of clapping hands, it is often the silence, absence, or emptiness from which meaning emerges.

While a recognition of *wu* is often implicit in LLMs, largely because of the databases from which they learn, its relevance becomes even more significant when considering more embodied systems. For example, given that *wu wei* is a non-deliberative and pre-reflective form of action, where humans act spontaneously in harmony with the structure of their environments, it *could* be argued that many existing robotics systems already capture aspects of *wu wei*. This is because these systems are typically designed to adapt and act within environmental constraints without deliberation and reflection.

While *wu* is implicitly recognised by these systems, to the extent that the gaps and distances between objects are also sensory inputs, it is the *you* of perceived objects that currently generates action, not *wu*. These embodied systems respond to sensory inputs, adjusting their movements in response to the changing structures of their environment. By recognising the metaphysical necessity of *wu*, researchers could design embodied AI systems that, much like humans, act contextually in response to the affordances that both presence and emptiness provide. This opens novel and exciting avenues for the development of AI and machine learning, especially when considering the potentially consistent relationship between innate effortless action and skilful activities that *wu wei* and neuroecological entrainment both suggest.

Neo-Confucianism can also introduce a moral perspective, specifically in its articulation of *li* and the moral metaphysics it entails. *Li* offers a kind of environmental structuring where cognition is not only metaphysically situated but also morally. Rather than viewing AI ethics as a mere add-on, Neo-Confucianism invites us to see ethical actions as inseparable from the metaphysical order of *li*, within which both humans and machines are

embedded. This could inspire AI systems whose ethical behaviours emerge not from imposed or arbitrary rulesets, but from their continuous and embodied participation in morally structured environments.

This also highlights the importance of ritual in AI development. Rather than programming fixed ethical rules for AI to follow, Neo-Confucian rituals are embodied practices that represent the moral order of the cosmos. This means that ethically meaningful practices could be enacted by structuring AI environments in alignment with the ordering principle of *li*. Furthermore, entrainment can provide an empirical mechanism for how this "upward" and "downward" morality might actually take place, offering a scientifically coherent way to harmonious AI systems with their environments. Given that, for Neo-Confucians, our environment is intrinsically moral, it may be the case that embodied AI systems that are allowed to engage with, respond to, and be shaped by environments structured according to *li* would spontaneously enact forms of moral cognition through their interactions. In this way, moral AI would be enacted by an embodied engagement with a morally structured world, and not by following explicit ethical theories or programs. The practices of *li* can reveal and reflect the moral order of the cosmos, potentially allowing AI systems to perceive and embody the moral structure of the world around them. Future research could embed morality into environmental design, prioritising *li* as a way to cultivate morality in AI systems.

In summary, Daoism and Neo-Confucianism offer unique and often overlooked avenues for expanding research on enacted cognition, with important applications for Computational Theories of Mind. Daoism highlights the importance of environmental structuring and the generative potential of *wu*, whereas Neo-Confucianism situates moral psychology within a cosmically ordered environment structured by *li*. The entanglement of art, life, and entrainment thus sits at the intersection of Daoist *wu wei*, Neo-Confucian *li*, and

computational cognition, revealing the mind as an aesthetic phenomenon, enacted and organised in the resonant space between action, emptiness, ritual, and ORDER. Contemporary AI research, when approached through these metaphysical frameworks, reveals exciting possibilities for integrating spontaneity, embodiment, enactment, and ethical structuring into artificial systems.

5.4 Concluding thoughts

As this dissertation has shown, art, life, and entrainment are all entangled, and this entanglement shapes what we are. Our actions and intuitions shape and organise the world which, in turn, shapes and organises our actions and intuitions, whether we are an artist or not. We are the enactment of the material, biological, and sociohistorical world in which both we and art are situated, and this world is a part of us. We are part of an ongoing creative process that both includes and transcends us. We are an enacted aesthetic phenomenon. We are *the* work of art.

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