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Dylan Schellenberg April 6, 2020

A Retinal Twitch, a Misfired Nerve Cell: The Neurocybernetics of *The Crying of Lot 49*

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Abstract

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This thesis investigates the neuroscience present in Thomas Pynchon's 1966 postmodern novel *The Crying of Lot 49* and its connections to cybernetics. Primarily, this thesis analyzes the cybernetic neuronal action potential that undergirds *Lot 49*'s entire meaning. In 1948, Norbert Wiener established the science of cybernetics. Pynchon took a great interest in cybernetics, subsequently imbuing *Lot 49* with Wiener's ideas. Cybernetics' main principle revolves around decreasing entropy through the process of feedback, something that also greatly impacted neuroscience. This concept of decreasing entropy implicates Maxwell's Demon, which attempts to violate the second law of thermodynamics with its molecular sorting. However, Maxwell's Demon cannot violate the second law because of the parallels between thermodynamic and informatic entropy. Critical analysis of *Lot 49* to date has focused on protagonist Oedipa acting as Maxwell's Demon, attempting but failing to decrease entropy through sorting methods.

My new reading of *The Crying of Lot 49* draws on the fact that mid-20th century neuroscience influenced Pynchon as greatly as cybernetics did. In 1952, English physiologists Alan Hodgkin and Andrew Huxley quantitatively elucidated the cybernetics-influenced neuronal action potential. This discovery by Hodgkin and Huxley led to neuroscience becoming a real discipline and exploding in cultural significance in the 1960's. Because neuroscience was a culturally and scientifically significant new field influenced by cybernetics, Thomas Pynchon incorporated its concepts into *Lot 49*. Primarily, the action potential is reflected in *Lot 49*, as it concerns cybernetically decreasing entropy through feedback loops to correctly transmit information. *Lot 49* exemplifies what happens when the action potential breaks down. As Oedipa's sorting methods fail and entropy rises in *Lot 49*'s universe, her neural feedback loops break and cause her to suffer seizures, which increase entropy neurologically.

Much neuroscience independent of cybernetics also saturates *Lot 49*, further illustrating that neuroscience was an important subject for the general populace and, consequently, Pynchon. *The Crying of Lot 49* accurately displays how neuroscience was viewed during its breakthrough genesis in the mid-20th century. *Lot 49* is therefore a postmodern reflection of neuroscience's philosophical and scientific notions, functioning as an important artistic document to the history of neuroscience.

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Table of Contents

Introduction: A Retinal Twitch, a Misfired Nerve Cell

The Crying of Lot 49 is a seminal postmodern novel written by Thomas Pynchon in 1966. *Lot 49*'s plot is simple enough on the surface: Oedipa Maas, a young California housewife, must execute an estate that her now dead ex-lover, Pierce Inverarity, leaves her. In executing this will, Oedipa embarks on a life-changing journey as she begins to unearth a worldwide conspiracy attached to Pierce's estate. This conspiracy, Oedipa soon realizes, centers around the mail and the way it is delivered. However, this plot synopsis belies the novel's true depth; there is much more to *Lot 49* than just an iconoclastic mail service, as will soon be realized.

Before moving forward to the rest of the thesis, "postmodern" needs first be defined. Postmodernism is a broad artistic and literary movement that originated after World War II. Postmodern works are primarily characterized by skepticism, irony, subjectivism, and irreverence. Postmodernists are suspicious of authority, reason, doctrinaire ideology, universal notions, and power in all forms. Postmodernism, most generally, is a sweeping rebuke of the influential modernist ideology that was the paramount arts/literature movement before World War II (Encyclopedia Britannica). On top of these general aspects, postmodern literature is more specifically characterized by fragmentation, paradox, unreliable narrators, dark humor, paranoia, parody, and metafiction. Postmodern literature often goes against outright meaning in a novel, instead presenting multiple correct meanings simultaneously or no meaning at all. Postmodern literature moreover purposefully mixes "high" and "low" forms of art/literature into one form, rejecting their boundary as a product of artificial ivory tower academic thought ("Postmodernism in Literature"). *The Crying of Lot 49* is often seen as a perfect example of the postmodern novel, as it exemplifies all the themes mentioned above and more (Castillo 39).

The Crying of Lot 49 explores Cold War, anarchist, surrealist, religious, pop culture, American Civil War, and Jacobean themes, to name just a few. Most importantly, however, *Lot 49* explores the themes of science and technology, with which Thomas Pynchon is almost infamous for being obsessed. The main scientific theme in *Lot 49* revolves around the concept of entropy and its relations to the thought experiment of Maxwell's Demon. Pynchon chooses Maxwell's Demon for two main reasons. One, Maxwell's Demon unites the fields of information theory, thermodynamics, and their related forms of entropy into one seamless whole. Two, Maxwell's Demon concerns the possibility of decreasing entropy in an isolated system, which implicates the science of cybernetics.

Cybernetics, the study of "control and communication in the animal and machine," concerns the ways organisms and machines locally decrease their systems' entropy through the process of *feedback* (Wiener 1). Cybernetics was established as a field by mathematician Norbert Wiener in 1948 and soon had sweeping impacts across numerous disciplines, including but not limited to computer science, sociology, philosophy, anthropology, and engineering. Pynchon metaphorizes the second law in *Lot 49* and makes its world an isolated system where entropy is constantly increasing. Therefore, in *Lot 49*, Pynchon utilizes cybernetics' anti-entropy feedback mechanisms as a beneficial weapon which protagonist Oedipa wields against the antagonistic forces that drive entropy upwards. Oedipa attempts feedback mechanisms to decrease entropy and continue healthy communication, a process that becomes harder as the novel progresses and entropy subsequently increases.

Among the fields most impacted by cybernetics was neuroscience. Neuroscience was firmly established as a field in the 1950's and 60's because of numerous technological and scientific advancements, like the microelectrode, that propelled revolutionary new discoveries.

Most particularly, the cybernetic feedback loop influenced neuroscience. In 1952, English physiologists Alan Hodgkin and Andrew Huxley quantitatively elucidated how the neuron electrically and chemically transmits its information. The neuronal action potential utilizes cybernetic feedback loops to achieve this transfer of information. Therefore, neurons decrease the entropy of their communications through cybernetic concepts. The elucidation of the neuronal action potential by Hodgkin and Huxley is still seen today as one of the greatest discoveries in the field of neuroscience and has been the foundation for virtually every other subsequent neuroscience discovery.

The Crying of Lot 49 came out 18 years after cybernetics was established and 14 years after the cybernetic neuronal action potential was elucidated. It is well known that Pynchon was influenced by Wiener's cybernetics around the time of writing *The Crying of Lot 49*. It is furthermore well known that cybernetics greatly affected neuroscience. However, the neuroscience present in *Lot 49* has not been analyzed. The fact that neuroscience was a leading scientific movement of the mid-20th century that was impacted by cybernetics means that Pynchon's ignorance or uninterest in the science is a virtual impossibility.

Accordingly, *The Crying of Lot 49* is chock-full of neuroscience. Particularly, the neurocybernetic concept of the action potential is vividly present in *Lot 49*. Because the neuronal action potential is a cybernetic process that concerns decreasing entropy with feedback loops to communicate information, it is the most widely capitalized neuroscientific concept in *Lot 49*. However, *Lot 49* is not just a novel about the communication of information; it is a novel about how the communication of information malfunctions as entropy continually rises toward heat death. Because of this fact, the action potential of *Lot 49* is also an investigation into what happens when these feedback mechanisms of the neuron go awry, causing neurological disorders

like seizures that increase entropy. Therefore, *Lot 49* as a novel can be read as one big action potential of a story: an action potential trying to decrease entropy with feedback loops to impart information, and an action potential that fails in this effort and increases entropy instead.

Most likely because neuroscience was a booming field during the time Pynchon was writing *Lot 49*, numerous stand-alone neuroscientific aspects are present in *Lot 49* as well. These neuroscientific concepts contain much significance for *Lot 49* and help elucidate many previously nebulous passages. A new and revelatory reading of *Lot 49* can therefore be achieved by analyzing its purely neuroscientific concepts in conjunction with its neurocybernetic to the point where it reads as an entirely different novel, a novel about neuroscience.[1]

The Crying of Lot 49 as a postmodern neuroscientific novel makes perfect sense. Neuroscience, although helped by cybernetics, was saturating the world in its own right. From the ionic basis of the nerve impulse by Kenneth Cole and Howard Curtis in 1939 and the first mathematical modeling of a neural network by Warren McCulloch and Walter Pitts in 1943 came Hodgkin and Huxley's 1952 quantitative elucidation of the neuronal action potential, from which an entire discipline evolved (Cowan et al. 345). After Hodgkin and Huxley's 1952 paper, a rash of programs, research institutions, and societies sprang up around the new discipline of neuroscience. In the mid 1950's, psychiatrist David Rioch brought together behaviorists and physiologists into one team at the Walter Reed Army Institute of Research, thus bridging the gap between psychiatry/behavior and anatomy/physiology for the first time in the study of the nervous system (Cowan et al. 345-346). In 1962, Frank Schmitt, who claims to have coined the term "neuroscience," established the neuroscience research program at M.I.T, a first of its kind

[1] Which is not to say, of course, that *Lot 49* can *only* be read as a novel about neuroscience, and all other readings are wrong. One of the many values of *Lot 49* lies in the fact that its breakthrough postmodern form nurtures multiple correct readings/meanings simultaneously.

(Cowan et al. 346). Neurobiologist James McGaugh founded a psychobiology program at UC Irvine in 1964, a precursor to their current neurobiology and behavior program (McGaugh 431). In 1966-1967, the most established and influential neuroscience program yet was created by physiologist Stephen Kuffler at Harvard in his creation of the department of neurobiology at Harvard Medical School (Cowan et al. 346-347). Kuffler's neurobiology program at Harvard formed the initial basis for modern academic neuroscience, of which similar departments soon appeared at other universities. This explosion of departments soon led to the formation of the Society for Neuroscience by psychologist Neil Miller, biochemist Ralph Gerard, and neurophysiologist Vernon Mountcastle in 1969, a society that now has ~37,000 members on its roll (Cowan et al. 347).

However, other neuroscientific societies and institutions were already created around the same time these inchoate academic departments were forming, before the Society of Neuroscience or Harvard's neurobiology program were ever truly established. In 1961, the International Brain Research Organization was founded ("History of IBRO"). Moreover, the Japanese Society for Neurochemistry was formed in 1962, which led to the creation of the International Society for Neurochemistry by 1965 ("About us"). Finally, the European Brain and Behavior Society and the British Neuroscience Association were both officially brought forth in 1968, right around the creation of the Society for Neuroscience ("About the EBBS"; "Our History"). Therefore, neuroscience was achieving monumental cultural and scientific impacts on the world starting in the mid 1950's into the 1960's as it was emerging as its own independent field from revolutionary breakthroughs like Hodgkin and Huxley's and Norbert Wiener's.

Because of neuroscience's sudden proliferation of cultural, societal, and scientific importance, it influenced virtually every other discipline and was on most everyone's mind in the

mid-20th century, including Pynchon's. As with every revolutionary scientific or technological breakthrough, there was a large mixture of enthusiasm, hope, fear, and anxiety over where neuroscience would take humanity. *The Crying of Lot 49* is a perfect reflection of mid-20th century neuroscience during its explosive burgeoning. *Lot 49* transcribes and explains popular opinion and thought on the then-novel study of neuroscience during the 1950's and 60's. In *Lot 49*, Pynchon casts all the positive and negative associations linked with neuroscience, indicating how neuroscience seamlessly connects with other sciences then-exploding, like information theory and cybernetics. Through this method, Pynchon displays how deep an interdisciplinary and humanistic quality neuroscience possesses through its profundity and cohesion with the themes of postmodern literature and science. Neuroscience is a deep science with numerous complex sides; if anything presents that fact best it would be *The Crying of Lot 49*, a postmodern novel on the surface about a postal system, but also about neuroscience.

Chapter One: Thermodynamics, Information Theory, and Maxwell's Demon

The 1867 physics thought experiment, "Maxwell's Demon," is inarguably the cornerstone of *The Crying of Lot 49*, as it beautifully exemplifies Thomas Pynchon's most infamous literary trope, entropy. Before beginning to understand what Pynchon is attempting to do metaphorically with Maxwell's Demon, however, one must understand the component scientific parts of the thought experiment. Namely, thermodynamics, information theory, and their related entropic phenomena must be properly elucidated. Only with an adequate understanding of these entropic elements of Maxwell's Demon can one understand the thought experiment itself and thus Pynchon's use of it in *Lot 49* in further conjunction with cybernetics, neuroscience, and more.

Thermodynamics

It is logical to touch on thermodynamics first in the process of elucidating the concept of entropy, as thermodynamic entropy is what most people picture when the word "entropy" is brought up, most likely in the form of gas molecules floating further apart from each other. Thermodynamics is the branch of "physics that deals with the mechanical action or relations of heat" (Merriam-Webster). A relatively new field of science, thermodynamics largely originated from the industrial revolution and its new technological requirements. Specifically, early industrial revolution thermodynamics focused its efforts on perfecting the efficiency of heat engines, which were a once trivial concept turned imperative by the advent of industrial technology (Marsden 1-2). Heat engines are "a mechanism (such as an internal combustion engine) for converting heat energy into mechanical or electrical energy" (Merriam-Webster). This conversion of heat energy into usable mechanical work is an ideal that James Clerk

Maxwell directly capitalized on in his Maxwell's Demon thought experiment only a few years later (Leff and Rex 4-6). The principal heat engine of the industrial revolution was the steam engine, which creates work through steam energy. Steam engines were ubiquitously used in the 19th century for war, industry, transportation, and everything in between (Simon 2). Accordingly, the pioneer of thermodynamics, French military scientist Sadi Carnot, originally proposed the first theory of heat engine efficiency in his 1824 *Reflections on the Motive Power of Fire* (which is arguably also the first text on thermodynamics) for the expressed purpose of utilizing steam engines to improve the standard of daily living (Thurston VIII).

As a science, thermodynamics was highly theoretical from its birth, however, and continues to be today. Thermodynamics is ruled by three main laws, which together define how the temperature, energy, and entropy of thermodynamic systems act in different contexts. For the purposes of this thesis, only the second law of thermodynamics, that "the entropy of an isolated system is always increasing; the energy available to do useful work is thus always decreasing" has any significance ("The Three Laws of Thermodynamics"). The second law of thermodynamics was postulated concurrently with the very birth of thermodynamics. Sadi Carnot laid the groundwork for the second law of thermodynamics in *Reflections on the Motive Power of Fire*, although he did not quite know its impact at the time: "The motive power of a waterfall depends on its height and on the quantity of the liquid; the motive power of heat depends also on the quantity of caloric [heat] used, and on what may be termed, on what in fact we will call, the *height of its fall*... In the fall of caloric [heat] the motive power undoubtedly increases with the difference of temperature between the warm and the cold

bodies" (Carnot 61).[2] Carnot describes the fall of heat from a higher to a lower temperature; from a state of usable to unusable energy as useful work is extracted out. This process of heat falling from a higher to lower temperature is where power comes from and can be used to run engines. Carnot's postulations went unrecognized for decades until the mid-19th century when physicist Rudolf Clausius used Carnot's work to state the second law of thermodynamics, and through it, define the concept of entropy for the first time.

Rudolf Clausius was a German physicist who, along with Carnot, Maxwell, and Lord Kelvin, did much to set the basic foundations of thermodynamics (Encyclopedia Britannica). Clausius took a serious interest in Carnot's 1824 work, which led him to devise the second law of thermodynamics as we know it today in his 1850 paper, "On the Moving Force of Heat" (Cropper 1068). Clausius then built upon this work with his 1867 publication, *The Mechanical Theory of Heat: With its Applications to the Steam Engine and to Physical Properties of Bodies*, in which Clausius states that "we might call S [now the universal variable for entropy] the *transformational content* of the body, just as we termed the magnitude U its *thermal and ergonal content*... I propose to call the magnitude S the *entropy* of the body, from the Greek word [for] *transformation*" (Clausius 357).[3] By using Carnot's ideas of heat fall (that heat can never pass from a colder to warmer body without externally applied energy) Clausius defined what entropy is for the first time, allowing him to reform his

[2] Carnot was rather prescient with this new definition, creating a footnote that explained that "the matter here dealt with being entirely new, we are obliged to employ expressions not in use as yet, and which perhaps are less clear than is desirable" (Carnot 61).

[3] Clausius is essentially correct about the Greek definition of entropy being "transformation," but could have gone a bit more in depth for further clarification and precision. Per the Online Etymology Dictionary: "[Entropy,] from Greek *entropia* 'a turning toward,' [which further stems from] *en* 'in' + *trope* 'a turning, a transformation' (from PIE root '*trep-*' 'to turn'). The notion is supposed to be "transformation contents.'" Thus, "trope" is the Greek word for transformation, and "entropia" (entropy) the Greek word for "a turning toward."

previous statements of the second law and thus succinctly state that "the entropy of the universe tends to a maximum" (Clausius 365). Carnot's and Clausius's formulations of entropy and the second law of thermodynamics are imperative for understanding both the underpinnings of thermodynamics and the environment Maxwell entered when he created Maxwell's Demon, but they still leave much to be desired concerning understanding exactly what these complex notions actually *mean*. What *is* entropy? What is the second law of thermodynamics *actually* saying with its use of entropy? These ideas will take a little more (modern) clarification before full comprehension can be reached.

Before delving further into entropy, a quick explanation of "system" is needed. In brief, "a system is a portion of the universe that has been chosen for studying the changes that take place within it in response to varying conditions. A system may be complex, such as a planet [or universe], or relatively simple, as the liquid within a glass" (Encyclopedia Britannica). Everything outside the system is the *environment* and is ignored except for its interactions with the system. An isolated system is a system that cannot interact with other systems and/or the environment around it; that is, thermodynamically speaking, neither energy nor mass can pass through the system ("The Three Laws of Thermodynamics"). For example, coffee in an insulated thermos is theoretically an isolated system; the temperature of the coffee stays hot for a long time because the insulated walls keep its heat energy in, while the lid keeps the physical coffee itself in. Thus, neither matter nor energy can leave the thermos. I say "theoretically isolated" because in reality, isolated systems are almost impossible – if not impossible – to maintain perpetually. The second law of thermodynamics was articulated in the terms of an isolated system, although there are also closed systems (through which energy but not matter can pass), and open systems (through which energy and matter can pass) ("A

System and Its Surroundings"). The concept of an isolated system will become very important in *The Crying of Lot 49*, as the world of *Lot 49* is an isolated system. Thus, entropy must continually rise for each character as no new energy is ever added.

Entropy is "a thermodynamic quantity representing the unavailability of a system's thermal energy for conversion into mechanical work, often interpreted as the degree of disorder or randomness in the system" (Oxford Dictionary). In practice, entropy is often equated with the number of ways a thermodynamic system can be arranged (into different specific *microstate* configurations). The higher the entropy, the higher the disorder, the more dispersal and unavailability of usable energy. The second law of thermodynamics states that this entropic disorder is always increasing in isolated systems. This claim means that if a process generates entropy, the process will happen spontaneously and will be irreversible (unless more energy is subsequently added) (Encyclopedia Britannica). Our universe is generally considered to be one massive isolated system, where entropy must gradually increase over time. Examples of this process are easily seen in daily life. For instance, pouring cream into coffee demonstrates the second law of thermodynamics. When cream is poured into coffee, its overall entropy increases. The disorder of the coffee and cream molecules increases, as the now unified system can be arranged in more ways when they mix. It is easy to visualize this process; the molecules of the coffee and the molecules of the cream both spontaneously tend to mix with each other in a higher entropic state, where they have more freedom to spread out and bounce into each other. Furthermore, you already intuitively know that the coffee and cream will never unmix; this event does not occur because of how much more greatly disorder is favored over order concerning a system's many microstates. Artistically, this increase toward a higher entropic state is seen as an increase toward blandness, sameness, and dispersal of landmarks, as Pynchon describes in *Lot*

49: “They rode over the bridge and into the great, empty, glare of the Oakland afternoon. The landscape lost all variety” (Pynchon 106). As the isolated world’s entropy increases in *Lot 49,* so does variety decrease.

If the second law of thermodynamics is correct and entropy is always increasing, why then does water still freeze into ice? Would not this transfer of order into disorder break the law? How about appliances like refrigerators? Do they not break the law? The freezing of water into ice does not break the second law of thermodynamics because it operates in an *open,* not *isolated* system. Even though the water’s state change to ice decreases entropy in its specific system transition, more energy is put in to create this anti-entropic state than the order ultimately formed from it, and thus the entropy of the surroundings increases even more as a result (“The laws of thermodynamics”). Freezing is an *exothermic process* – “accompanied by the release of heat” (Oxford Dictionary) – most of the energy used to make ice is subsequently lost from the transition and dissipated into the world, increasing the overall entropy of the universe (“The laws of thermodynamics”). This process works the same way with the fridge: it must reconcile its decrease in entropy with a higher input of electrical energy into the system to maintain coldness, and thus a further release of higher entropy outside its system into the environment (“Basics of refrigeration”). This process occurs in all open systems and indicates how organisms lose entropy and keep order, provided they take in more external energy than the order they create and consequently release it to the surrounding environment (and thus universe) to ultimately increase universal entropy. As will be shortly discussed, this aspect of needing to import more external energy than the order subsequently extracted is why Maxwell’s Demon was such a revolutionary thought experiment, and moreover why the characters in *Lot 49* are obsessed by its concept in their entropic world.

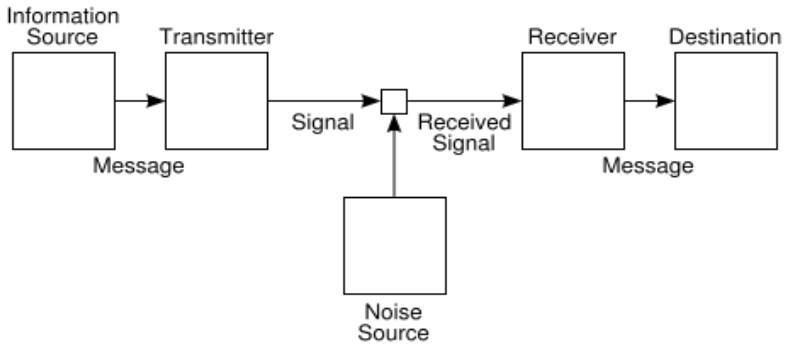
Entropy presents itself as a fundamental principle of energy constantly expending itself to create greater and greater disorder/dispersal. This constant increase in disorder exemplifies the second law of thermodynamics, which eventually leads to *heat death*, "a state of uniform distribution of energy, especially viewed as a possible fate of the universe" (Oxford Dictionary). Heat death is postulated to be the ultimate fate of our universe, when no more free energy is available to decrease entropy. Although we don't have to worry because heat death won't happen to us for approximately $10^{\wedge 26}$ years, the characters in *Lot 49* do as their isolated universe rapidly evolves toward this final nightmare state ("The fate of the universe").

Information Theory

Before full comprehension of Maxwell's Demon can be reached, we must fast-forward in time and focus on one man: Claude Shannon. Claude Shannon was an American mathematician and electrical engineer who largely founded the field of information theory while working as a scientist at Bell Labs with his 1948 paper, "A Mathematical Theory of Communication" (Encyclopedia Britannica). Information theory is "the mathematical study of the coding of information in the form of sequences of symbols, impulses, etc., and of how rapidly such information can be transmitted, e.g., through computer circuits or telecommunications channels" (Oxford Dictionary). Information theory studies the steps of information communication from one entity to another. In *A Mathematical Theory of Communication,* Shannon – with inspiration from Norbert Wiener (more on him later) – focused on how to best encode information a sender wants to communicate. Shannon's paper sets down the fundamental elements of communication as per information theory:

1. An *information source* which produces a message or sequence of messages to be communicated to the receiving terminal.

2. A *transmitter* which operates on the message in some way to produce a signal suitable for transmission over the channel.
3. [A] *channel* [which is] … used to transmit the signal from transmitter to receiver.
4. [A] *receiver* [which] ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal.
5. [A] *destination* [which] is the person (or thing) for whom the message is intended. (Shannon 380-381).



Shannon's original schematic of an information theory communication system.

Source: "Shannon Communication System." *Wikimedia Commons*, 17 Feb. 2008, commons.wikimedia.org/wiki/File:Shannon_communication_system.svg.

In *A Mathematical Theory of Communication*, information is thought of as a set of all possible messages in a pool, not the actual elucidated content in the messages. Shannon wanted to be able to send messages over a "noisy" channel (a channel in which random, unwanted, negative, influences consistently have impacts) and have them correctly reconstructed in the receiver. Through this elucidation, Shannon developed the defining concept of information *entropy*.

Information entropy defines entropy as the measure of information in terms of uncertainty. The higher the uncertainty, the higher the entropy; the higher the entropy, the higher the amount of information is in the message (or system). Higher information entropy, uncertainty, and amount of information in a message are often synonymous with *noise*. The

noisier a message is, the harder it is to parse out for the receiver, and therefore the more entropy it contains. Information entropy is quite like thermodynamic entropy, although it may not seem so at first ("A Gentle Introduction to Information Entropy").[4] A quick example may clarify this problem: which has more informational entropy, a coin flipped with heads on both sides, or a coin flipped with a head and a tail? This problem is easily answered using only yes/no questions. The more yes/no questions you must ask, the more states the coin could potentially be in, so the more information it technically holds. Concerning the coin with only heads, it is superfluous to ask any questions; you already know that both sides of the coin are heads. Thus, the entropy of the coin with two heads is zero, and it has zero bits (the universal unit of information) as a result; there is no uncertainty or "surprise" in flipping the coin. Concerning the coin with both heads and tails, however, you must ask "Is the coin heads?" or "Is the coin tails?" Once you ask this question, whether the outcome is yes or no, you know your answer. Thus, it takes one yes/no question to know on what side the flipped coin with a heads and tails has landed. The entropy is one, and it has one bit as a result. This entropic concept can be applied to any form of information, from our written words to balls in a bucket.

This information entropy tenet is not without its caveats, however. For instance, English is not just a random sequence of letters: vowels, spaces, grammar, punctuation, etc. all make English less random. These rules are called *redundancies* in information theory. Taht's wyh yuo cna porbalby raed tihs esaliy desptie teh msispeillgns; redundancies help lower information

[4] Per philosopher of science David Hawkins' words: "When the molecules of a gas, for example, are in a collective state of maximum entropy, or disorder, all the alternatives consistent with the given total energy are equally probable, and therefore, by the most efficient method of measurement possible, the precise determination of the exact state of the gas will require the maximum amount of information" (212). The more thermodynamic microstates a system can be in, the more information is needed to describe the system. A thermodynamic system with maximum entropy has maximum *uncertainty* because the number of possible microstate "messages" in the "pool" able to be elucidated from the system's total microstate configurations is also at a maximum.

If three machines are spitting out information of A's and B's in exactly this pattern forever, which machine is sending the most information? Machine 3, because it has the least amount of redundancy. Thus, machine 3 has the highest entropy.

My Diagram

entropy so we can read a word even if we can understand only some of the parts. In situations where information can easily be lost, redundancies make it possible that communication can still occur. Redundancy is ultimately why the information entropy per letter for English is (calculated by Claude Shannon) 2.62 bits, not 4.7 (Shannon, *Prediction and Entropy* 53-54). The fundamental conclusion here is that if the entropy of a message drops, that means you have to ask fewer questions to guess the outcome, and it is thus easier to parse it out for the receiver.

In *Lot 49*, as entropy rises, so does the uncertainty of messages. Once again, this phenomenon occurs because of the intimate link between thermodynamic and informatic entropy. As per literary critic J. Kerry Grant's words, protagonist Oedipa in *Lot 49* " becomes a receiver, attempting to resolve the signals that emanate from her word into a discrete and organized message which will contain a meaning," which is hard because these messages are privy to "interference in the form of 'noise,' which reduces the probability that any given signal will be received in precisely the form in which it was transmitted" (119). As the entropy of *Lot 49* rises, the characters attempt everything in their power to decrease information entropy and make communication possible through the correct reconstruction of transmitted messages.

Thermodynamics largely originated in the mid-19th century, while information theory began in the mid-20th century. Thus, when Maxwell created his Demon, he was only thinking in the context of thermodynamics, *not* information theory. That being the case, how does

Maxwell's Demon incorporate both thermodynamics and information theory? How then is Maxwell's Demon the perfect model for the parallel between informatic and thermodynamic entropy, if it originated ~80 years before Claude Shannon's publication? As we move on now to discuss Maxwell's Demon, these questions will all be answered.

Maxwell's Demon

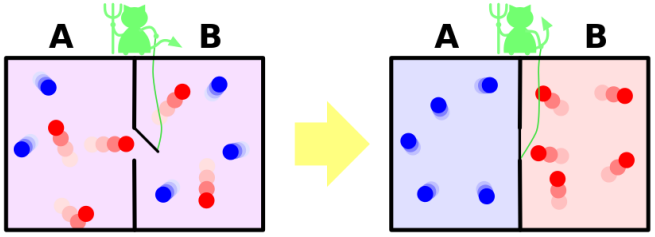
James Clerk Maxwell was a 19th-century Scottish physicist who greatly advanced the fields of thermodynamics, electromagnetism, special relativity, and quantum mechanics, among many others (Encyclopedia Britannica). Maxwell – more than any other physicist before him – impacted modern physics through his groundbreaking thoughts, which could fill multiple books (Nahin 45; Campbell 1). Only one of Maxwell's thoughts – or more precisely, thought experiments – concerns us here, however: Maxwell's Demon.

Maxwell devised the Demon in 1867, the same year Rudolf Clausius published *The Mechanical Theory of Heat*. The thought experiment was then finally incorporated into his seminal 1872 thermodynamic work, *Theory of Heat* (Leff and Rex 370). Maxwell's Demon concerns how the recently conceived second law could theoretically be broken, generating free power as a result. As Maxwell states in *Theory of Heat*:

> But if we conceive a being whose faculties are so sharpened that he can follow every molecule in its course, such a being, whose attributes are still as essentially finite as our own, would be able to do what is at present impossible to us. For we have seen that the molecules in a vessel full of air at uniform temperature are moving with velocities by no means uniform, though the mean velocity of any great number of them, arbitrarily selected, is almost exactly uniform. Now let us suppose that such a vessel is divided into

> two portions, A and B, by a division in which there is a small hole, and that a being, who can see the individual molecules, opens and closes this hole, so as to allow only the swifter molecules to pass from A to B, and only the slower ones to pass from B to A. He will thus, without expenditure of work, raise the temperature of B and lower that of A, in contradiction to the second law of thermodynamics (Maxwell 308-309)

Maxwell formulates a Demon[5] that can control a small hole between two containers of gas that together comprise one larger container. The gases in both containers are in equal entropic states/temperatures. The Demon knows/can calculate all the speeds of each gas molecule in the container. The Demon can observe the individual gas molecules in both chambers and open its hole to let only fast molecules container into one container (let us say container B) and cold into the other (A). Because the average speed of the molecules in container B will be faster than the average speed of the molecules in container A, container B will be hotter in temperature than container A. Consequently, the entropy of container B will increase while the entropy of container A will decrease, and the container as a whole will be in a much more highly ordered state than it was previously when mixed. Maxwell's Demon would thus break the second law of thermodynamics, decreasing the entropy of the entire container. This newfound order can be used to drive a heat engine that creates free energy from the temperature differences between the two containers.[6]



Maxwell's Demon decreasing entropy by shuttling gas molecules

Source: "Maxwell's Demon." *Wikimedia Commons*, 13 Feb. 2008, commons.wikimedia.org/wiki/File:Maxwell%27s_demon.svg.

[5] Maxwell used the term "being" in *Theory of Heat*: Lord Kelvin was the first to use "Demon" in 1874 (Weber 300).
[6] Pynchon's explanation of the Demon is quite accurate and in-line with other scholars and scientists: "James Clerk Maxwell… [was] a famous Scotch scientist who had once postulated a tiny intelligence, known as Maxwell's Demon. The Demon could sit in a box among air molecules that were moving at all different random speeds, and sort out the fast molecules from the slow ones. Fast molecules have more energy than slow ones. Concentrate

Although on the surface Maxwell's thought experiment may seem like some pointless philosophical exercise, it would have huge potential for the world if realized. If a working Maxwell's Demon machine could be built to successfully defy the second law of thermodynamics, then you could literally "get something for nothing" and create a self-powered heat engine that does useful mechanical work without any need for outside energy input ("Heat Engines"). Machines that could produce work without any need for a previous input of energy would revolutionize our life; no more channeling in of electricity to power your refrigerators, TV's, etc.! It seems from information in the Demon's mind alone, that Maxwell was able to crack the second law of thermodynamics and create work out of pure entropy. Experimenters tried for many years to create "something from nothing" with inventions that created their own energy source such as the self-powered perpetual motion machine, but they all failed (Tsaousis 53). Of course, we now know why that was so; information, too, contains entropy.

Leo Szilard was the first scientist to point out the true flaws in Maxwell's thought experiment and propose why it did not break the second law of thermodynamics. Szilard was an American-Hungarian physicist who is best remembered for his work in nuclear physics and his relations to the Manhattan Project (Encyclopedia Britannica). Before any of this famous work occurred, Szilard finally cracked Maxwell's Demon. In his 1922 dissertation, *On The Manifestation of Thermodynamic Fluctuations* and following 1929 paper, "On the reduction of entropy in a thermodynamic system by the intervention of intelligent beings," Szilard explains why the second law of thermodynamics is not broken by the Demon: "When such [Demons] make measurements, they make the system behave in a manner distinctly different from the way

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enough of them in one place and you have a region of high temperature. You can then use the difference in temperature between this hot region of the box and any cooler region, to drive a heat engine. Since the Demon only sat and sorted, you wouldn't have put any real work into the system. So you would be violating the Second Law of Thermodynamics, getting something for nothing, causing perpetual motion" (Pynchon 68).

a mechanical system behaves when left to itself. We show that it is a sort of a memory faculty, manifested by a system where measurements occur, that might cause a permanent decrease of entropy and thus a violation of the Second Law of Thermodynamics, were it not for the fact that the measurements themselves are necessarily accompanied by a production of entropy" (Szilard 301). Szilard, more neuroscientifically, states on this theme that "in eliciting any physical effect by action of the sensory as well as the motor nervous systems a degradation of energy is always involved, quite apart from the fact that the very existence of a nervous system is dependent on continual dissipation of energy" (quoted in Lanouette et al. 66).

Szilard united the older fields of thermodynamics and classical mechanics with the then-new field of quantum mechanics to present that, by observing and taking measurements of the gas in its system, the Demon cannot help but change its system and subsequently raise entropy (Lanouette et al. 65). Szilard mathematically argues that to do its job, the Demon must be making calculations and thinking constantly about the gas molecules. Although the Demon is lowering the container system's entropy through these thoughts with its sorting, it is also causing the Demon's mental energy to organize all the thoughts in its brain. Therefore, as the Demon starts to make measurements and form memories, the information entropy of its brain constantly rises as it attempts to sort through all the random gas molecule information of its container. It is assumed that the Demon can only hold a finite amount of information in its brain, so when its brain gets full, the Demon must erase previous information to make room for more. This deletion of information costs energy and is exhausted outside the Demon's brain system into the container's system. Heat entropy is created through this exhaustion of information, and the entropy of the container's system is subsequently increased more than what the Demon

previously creates through its organizational order (Lanouette et al. 65-67). Thus, entropy is still rising in the container, and the second law of thermodynamics is not broken.

Considering the milieu in *The Crying of Lot 49*, it is not hard to see why its characters would be obsessed with the Demon concept. In their isolated system where no external energy input can intrude to break the entropic rise toward heat death, a machine that could decrease the world's entropy from the *inside out* without needing external energy would be a literal lifesaver. For that same reason, however, the Demon turns out to be a huge disappointment for *Lot 49*'s characters. The Demon cannot decrease their world's entropy by itself. Thus, entropy continues to rise in *Lot 49* as external energy cannot be communicated to the entropy-defying Demon. As will be shown, this entropic and anti-communicative circumstance not only has implications for thermodynamics and information theory, but also cybernetics and neuroscience.

Szilard also conceived the Szilard engine in his 1929 paper, a thought experiment based on Maxwell's Demon that demonstrates how information can have thermodynamically anti-entropic consequences (Pal and Jayannavar 2-3). Szilard furthermore greatly helped to develop the concept of "negentropy" through this thought experiment (Brillouin 1153). Negentropy is negative entropy, or molecules becoming more ordered (Oxford English Dictionary). French physicist Léon Brillouin derived a general equation for negentropy in 1953, based on the workings of Szilard's engine (Brillouin 1152-1153). Through this equation, negentropy was intimately linked with information theory and thermodynamics. It is not hard to connect the concept of negentropy to Maxwell's Demon. All Maxwell's Demon attempts is negentropy through its gas sorting; scientists after Brillouin made this same connection and started using the term when describing Maxwell's Demon.

Szilard tackled the age-old Maxwell's Demon problem by realizing the connection between information theory and thermodynamics for the first time. However, no one – including Szilard himself – significantly pursued this information/thermodynamics connection further until Claude Shannon. When Shannon finally took up this connection and used it to create the field of information theory in 1948, he acknowledged Szilard as the "true" founder of information theory and entropy (Lanouette et al. 67). If anything, this scenario exemplifies how connected these scientists were in thought despite huge differences in discipline, time, and place. These concepts of thermodynamics, Maxwell's Demon, and information theory, moreover, each connect with cybernetics, neuroscience, and Pynchonian literature, all of which relate to each other in thought too. Therefore, in the succeeding chapters, thermodynamics, information theory, Maxwell's Demon, cybernetics, and neuroscience, in that order, will all shown to be intimately connected with each other and active in Pynchon's works.

Chapter Two: Cybernetics

Cybernetics is a transdisciplinary study that connects the worlds of Pynchon, thermodynamics, information theory, and neuroscience into one beautifully wrapped whole, its implications still producing massive impacts in the present day. Cybernetics, or the scientific study of "control and communication in the animal and the machine," was formulated by mathematician Norbert Wiener in the 1940's along with other prominent neuroscientists, physicians, engineers, and mathematicians (Wiener, *Cybernetics* 15). The science of cybernetics concerns itself with the concept of entropy and how to temporarily decrease its constant universal escalation, creating negentropy in its place. Because of these facts, throughout this cybernetics chapter, information theory, thermodynamics, Maxwell's Demon, neuroscience, and Pynchon's works will be routinely evoked to present the intimate association each study has with cybernetics.

Norbert Wiener was a child prodigy who obtained his PhD in mathematics from Harvard at age 18 (Conway and Siegelman 27). Between Harvard and World War II, Wiener worked on numerous mathematical notions such as Brownian motion, Fourier transformations, and Tauberian theorems, before eventually bridging into his defining cybernetic work (Wiener, *Mathematician* 109; 122; 156). It was during World War II that Wiener's real work – and consequently cybernetics –took off. World War II stimulated scientific thought more than any other event at the time possibly could have. Since so many nations were embroiled in a global conflict, numerous reputable scientists and intellectuals were deployed for the sole effort of war, and advancements that normally would have taken decades were instead achieved in a few years. This conflict naturally impacted Wiener, who used his electrical network and "computing machine" background to study information theory independent of Claude Shannon. Wiener

funneled his knowledge into the perfection of anti-aircraft artillery guns to shoot down Axis planes attempting to bomb London (Wiener, *Cybernetics* 3-5). This anti-aircraft work led Wiener to develop the Wiener Filter, a filter that reduces the amount of noise present in a signal to more effectively predict the position of German bombers from radar (Heims 182-184).

Because planes in WW II were becoming so technologically advanced, it was imperative for Wiener to model his anti-aircraft equations for the future based on incomplete information about the past (Heims 183). A V1 bomber "airplane has a velocity which is a very appreciable part of the velocity used to bring it down" (Wiener, *Cybernetics* 5). One must shoot the missile not at the plane itself, but at an area in the sky where the plane will meet the missile in future time and space. Thus, anti-aircraft guns must predict the future position of where the plane is believed to travel and fire there rather than firing at the plane's current position. The prediction of an airplane's future flight path based on its past carried Wiener into the building of proto-cybernetic apparatuses and the modeling of information signals as inherently random noise.

This forecasting of an aircraft's future incorporated the parallel between man and machine, a cornerstone of soon-to-be-cybernetic thought. To most accurately shoot down Axis warplanes, Wiener and his war team even considered the muscular movements of the pilot in control of the plane. Wiener explains that most often there is a human component coupled with the control of anti-aircraft gun systems that exerts an influence on how the gun effectively operates. Thus, "it is essential to know [the human component's] characteristics, in order to incorporate them mathematically into the machines they control" (Wiener, *Cybernetics* 6). The actual plane the anti-aircraft guns are attempting to shoot down is also inextricably influenced by human variables, as humans obviously fly WW II planes. Because of this fact, "it is desirable to know [the plane's] performance characteristics" in the context of its intimate linkage with the

human operator and their muscular movements driving the plane (Wiener, *Cybernetics* 6). This breakthrough consideration in the modeling of anti-aircraft artillery was one of Wiener's first forays into the cybernetic idea of the parallel nature between life and machine concerning the ways they operate, regulate, function, and communicate (Wiener, *Human* 16).

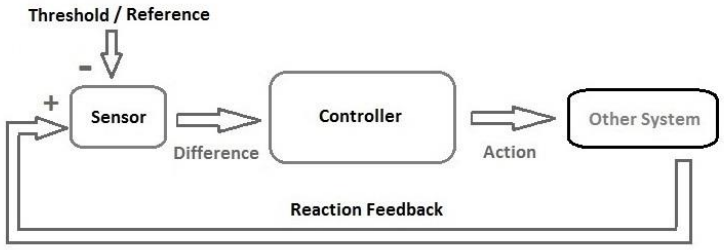
Shortly after WW II, cybernetics was established as a discipline by Wiener as well as neurophysiologist Warren McCulloch, physician Arturo Rosenblueth, psychiatrist Ross Ashby, mathematician John von Neumann, and logician Walter Pitts among others at scientific conferences hosted by organizations such as the Macy Foundation (Wiener, *Cybernetics* 17-23). The exact definition and study of cybernetics is ambiguous, since it is such a broad field. However, for the purposes of this essay, cybernetics can be defined as the study of systems (digital, mechanical, biological, chemical, social, cognitive, etc.) and how they receive exterior information, process that received information, and then react to that information with actuators to change their receiving, processing, and reaction of stimuli in the future for the betterment of the systems' functioning and regulation as a whole. The cybernetic system constantly changes its environment and then adapts to environmental changes through preprogrammed yet adaptable processing and response to received information, going from a state of action to a state of sensing/processing, and then back again to a state of action in a *closed feedback loop*.

The concept of *feedback* is so central to cybernetics that the field itself could not exist without this process. A system is not fundamentally cybernetic without a feedback loop of some sort. Considering the importance of feedback, what then is its definition? Wiener states that the "control of a machine on the basis of its *actual* performance rather than its *expected* performance is known as *feedback*, and involves sensory members which are actuated by motor members and perform the function of *tell-tales* or *monitors* - that is, of elements which indicate a performance"

(Wiener, *Human* 24-25). Feedback is the aspect of the cybernetic system that contests the universal inclination toward heat death. This definition provided by Wiener moreover evokes my previous definition of a cybernetic system. Feedback is so closely linked to cybernetics that you cannot define one without defining the other.

Later in *The Human Use of Human Beings,* Wiener expands his definition of feedback to include *all* systems, not only those that are machinic. Wiener elaborates that "feedback is a method of controlling a system by reinserting into it the results of its past performance" (Wiener, *Human* 61). If the reinserted results of the system's past performance are used as basic spreadsheet data for the purpose of subsequent analysis by human specialists, then the cybernetic system is enacting a *simple* sort of feedback and not constantly adapting to its surroundings in real time. "If, however, the information which proceeds backward from the performance is able to change the general method and pattern of performance, we have a process which may well be called learning" (Wiener, *Human* 61). A system learns through changing its future performance based on reinserted information from its past performances. This aspect of *learning* through cybernetic feedback is crucial to protagonist Oedipa's quest as she attempts to sort through a massive influx of information. Oedipa changes her thoughts and behavior based on the past information she gains and then cybernetically reinserts this information for the future in a feedback loop of attempted negentropy.

Finally, Wiener parallels feedback processes between human and machine. Discussing muscle contraction and use, Wiener argues that "the mechanism of voluntary [muscle] activity [is] of a feedback nature," so he consequently looks for the breakdown characteristics voluntary muscle activity "feedback mechanisms exhibit when they are overloaded" (Wiener, *Human* 163). Wiener found that "the simplest type of breakdown exhibits itself as an oscillation in a goal-seeking process," which manifests itself when that goal-seeking muscular process is being directly utilized (Wiener, *Human* 163). This analysis brings Wiener to intention tremor, a neurological disorder where "for example, when the patient reaches for a glass of water, his hand swings wider and wider" until he cannot grasp the glass (Wiener, *Human* 163). This disorder occurs because to perform a conscious effort successfully, the muscles that are not directly contracting in the movement "must be kept in such a condition of mild *tonus* or tension" to successfully support the muscles being directly acted upon (Wiener, *Human* 164). In intention tremor, "a secondary feedback mechanism" that normally controls these supporting muscles breaks down, and the patient cannot control their voluntary movement anymore (Wiener, *Human* 164). Instead of producing negentropic effects through their feedback loops as they would normally, the damaged supporting muscles in intention tremor go haywire. The muscles are still producing feedback loops, but feedback loops



A Cybernetic Loop

A simple cybernetic loop of sensing, processing, and acting on information to better change future operation of the system by feeding the output reaction information back into the input sensor ad infinitum.

Source: "Cybernetics." *Wikimedia Commons*, 24 July 2015, commons.wikimedia.org/w/index.php?curid=40308646.

that spiral out of control and actually *increase* disorder and entropy instead of *decreasing* it because of their malfunction.

In drawing parallels between the feedback mechanisms of human and machinic systems, Wiener brings in his notion of negentropy in man and machine. One of Wiener's main theses in *The Human Use of Human Beings* is "that the physical functioning of the living individual and the operation of some of the newer communication machines are precisely parallel in their analogous attempts to control entropy through feedback" (Wiener, *Human* 26). To Wiener, both machines and humans are "pockets of decreasing entropy in a framework in which the large entropy tends to increase," and locally swim upstream against the current of increasing entropy with "anti-entropic processes" of feedback that are "neither biological nor mechanical" in nature and temporarily build up "organization and its correlative, information" (Wiener, *Human* 31-32). In *Lot 49*, this analogy of man and machine as comparable negentropic feedback systems will become crucial when considering the neuroscientific aspects of the novel along with the more conventional informatic and thermodynamic readings. Although Wiener asserts that machines (so far) do not have anything that can be labeled "heart," soul," or "spirit,"[7] he argues that machines are parallel to humans and all other living organisms in that they all fight against the universe's ever increasing levels of entropy (Weiner, *Human* 32).

These descriptions of anti-entropy/negentropy immediately bring to mind the previously discussed thought experiment of Maxwell's Demon and its entropy-defying properties of sorting gas molecules. Maxwell's Demon as a negentropic being seems the perfect cybernetic structure in theory. However, Wiener brings up Maxwell's Demon himself in *The Human Use of Human*

[7] A notion of Wiener's that Pynchon seems to have picked up in "Entropy," an early short story: "and as every good Romantic knows, the soul (*spiritus, ruach, pneuma*) is nothing, substantially, but air" (Pynchon, *Slow Learner* 83).

Beings to point out that the Demon cannot defy entropy by virtue of its cybernetic sensing structures. The Demon "can only gain the information with which it opens or closes the door from something like a sense organ which for these purposes is the eye" (Wiener, *Human* 29-30). The light information that strikes the Demon's eyes "cannot indicate the position of any particle unless it hits the particle as well," and therefore "we cannot consider the gas chamber as containing mere gas, but rather gas and light" (Wiener, *Human* 30). However, if the gas and the light were in equilibrium, the Demon would be blind because it would be as if "a cloud of light [was] coming from every direction, giving no indication of the position and momenta of the gas particles" (Wiener, *Human* 30). Thus, "the Maxwell demon will work only in a system that is not in equilibrium. In such a system, however, it will turn out that the constant collision between light and gas particles tends to bring the light and [gas] particles to an [entropic] equilibrium" where the Demon once again is unable to sort (Wiener, *Human* 30). The Demon therefore cannot decrease entropy overall because even though its sorting may temporarily decrease entropy, "ultimately it too will wear down" (Wiener, *Human* 30). Thus, Maxwell's Demon "can work indefinitely only if additional light comes from outside the system and does not correspond in temperature to the mechanical temperature of the particles [in the chamber] themselves," which would defeat the entire purpose of Maxwell's Demon being in an isolated system without access to external energy sources (Wiener, *Human* 30). Essentially, the cybernetic sensors of the Demon are needed to perform its sorting in the first place, and these very same sensors are by virtue what causes the entropy to increase to a point of no return in the Demon's chamber. As Wiener says to start out his discussion on Maxwell's Demon, "but even more important [than taking in food as energy from the outside world] is the fact that we take in information through our sense organs, and we act on information received" (Wiener, *Human* 28). The Demon takes in

information through its visual sense organ and acts on it to transiently decrease entropy, but the composition of light and gas particles needed to take in said information in the first place causes the entropy in the Demon's chamber to ultimately increase to a point where the Demon can no longer see to sort at all. The entropy in the Demon's chamber goes up as a direct consequence of information entropy. It costs something to get information; the light and gas information composition needed in the Demon's container for it to correctly perform its information sorting eventually must raise entropy to the point where the Demon can no longer correctly utilize any information in the chamber because of its "entropic" blindness.

Keeping in mind this cybernetic explanation of why Maxwell's Demon cannot defy the second law of thermodynamics is crucial for understanding *The Crying of Lot 49*. Wiener's elaboration that Maxwell's Demon requires an environment in its isolated system to effectively sort with its cybernetic sense organs that ultimately increases entropy occurs to protagonist Oedipa. Oedipa, like the Demon, is in an isolated system. Moreover, Oedipa, like the Demon, raises her isolated system's entropy through her peripheral sense organs, which require an entropy-increasing milieu to correctly operate. This phenomenon becomes even more significant when the neurological aspects in *Lot 49* are analyzed, as they introduce the neurophysiological feedback mechanisms underlying Oedipa's perceptive organs and why they eventually promote entropy increase when they break as a result of Oedipa being synonymous with Maxwell's Demon.

To stress the Maxwell's Demon point a little further, cybernetics is not only entropically connected with thermodynamics (as stated above), but also with information theory. To Wiener, order is synonymous with message and disorder with noise: "Organism is opposed to chaos, to disintegration, to death, as message is to noise. To describe an organism, we do not try to specify

each molecule in it, and catalogue it bit by bit, but rather to answer certain questions about it which reveal its pattern" (Wiener, *Human* 95). Homeostasis is a pattern that keeps organisms alive and fights against universal entropy. The touchstone of an organism's identity "is the pattern maintained by … homeostasis," which makes living beings "not stuff that abides, but patterns that perpetuate themselves" until they eventually decay more than reconstitute and die (Wiener, *Human* 96). Echoing Claude Shannon, Wiener claims that "A pattern is a message, and may be transmitted as a message" (Wiener, *Human* 96). A pattern is a message that is negentropy fighting against noise and entropy. Therefore, in the eyes of cybernetics, a system does not only take messages into the sense organs to process and act upon to decrease entropy with feedback, but are also messages fighting against entropy themselves. Pynchon in *Lot 49* alludes to this notion of human as message/pattern by stating through a character that "you're an antenna, sending your pattern out across a million lives a night, and they're your lives too" (Pynchon 118). A message is order; an organism is order; a pattern is order; and a message is a pattern is an organism, all enclaves of stability against disorder, noise, and nothingness. Thus Shannon, Maxwell, and Pynchon come together in the science of cybernetics, showing the hand-in-hand fight organisms and message information are attempting against the second law.

With his thoughts on all intelligent behavior being the result of feedback mechanisms, Wiener was one of the first individuals to bring the current AI revolution into its modern-day form ("Return of Cybernetics"). Wiener's AI revolution gained traction soon after the foundation of cybernetics in 1948, an aim of which Pynchon was conscious even in the late 1950's. In his 1960 (although written in 1959) short story "Entropy," a character becomes "bugged at this idea of computers acting like people," and even grows furious at the prospect of looking at "human behavior like a program fed into an IBM machine" (Pynchon, *Slow Learner* 90). Cybernetics and

AI were synonymous for many from the get-go, an association Pynchon injected straight into his literature. Accordingly, although in 2020 Wiener is not usually credited with the creation of AI, when the contemporary AI that we all know and love today was created by John McCarthy at the 1956 Dartmouth conference, he avoided any connection with Wiener's cybernetics because of the magnitude of its implications for AI up to that point (McCarthy 73).

Although purely computational/digital AI and automation is inarguably the largest result of cybernetics, a quite underrepresented implication of the cybernetic revolution occurred in the field of neuroscience. One of Wiener's main studies of cybernetics concerned the human brain as an analogy for a computer (McCarthy 46). Wiener's definition of feedback is often hinged on neurophysiology. This notion is illustrated in the intention tremor instance above, and an example that Wiener provides of picking up his cigar with his hand so that he turns "into action a certain feedback mechanism" with his active muscles to pick up the cigar and increase "order to the lagging muscles" (Wiener, *Human* 26). Often cybernetics is only brought up in the light of a neurophysiology of machines, as they are the most realistic to compare. This connection of man and machine in the context of nerves/neurophysiology leads Wiener into "the semi-medical purposes [of] prosthesis and replacement of human functions which have been lost or weakened in certain unfortunate individuals" (Wiener, *Human* 163). Furthermore, many individuals present at the Macy Conferences were neurophysiologists. Among these neuroscientists were neurocyberneticists Warren McCulloch and Walter Pitts, who eventually produced the first mathematical model of a neural network in their seminal 1943 paper, "A Logical Calculus of Ideas Immanent in Nervous Activity," which stands as a precursor to the eventual elucidation of the neuronal action potential by Hodgkin and Huxley in 1952 (McCulloch and Pitts). Wiener talked extensively with John von Neumann and others on the modeling of the neuron in

cybernetic feedback terms. His thoughts in the early cybernetic movement were "mainly focused on the subject of neurology, and more specifically on the human nervous system" as per von Neumann's words (Rédei 278). In 1962 the Royal Dutch Academy of Sciences held a symposium on cybernetics that centered on the three main subjects of "nerve, brain, and memory models," where many prominent "neurologists, psychiatrists, biologists, engineers, mathematicians and physicists [covered] many intriguing problems and theories in [the] field of bionics" (Wiener, "Neurocybernetics" 4). Since neuroscience was so readily on the mind of Wiener and present in all facets of the cybernetics movement, it is not surprising how quickly cybernetics influenced the then-fledgling field of neuroscience. Accordingly, Wiener and many other cyberneticists caused breakthroughs to occur in neuroscience in and after their careers.

There are many neuroscientific paths traceable from the origins of cybernetics. Walter Pitts and Warren McCulloch helped originate the prominent field of computational neuroscience as it is known today based on their 1943 neuron modeling work already discussed (Smalheiser 217). This same neuronal modeling work was one of the first projects to broach the parallels between modern AI networks and neuronal networks (Smalheiser 217). Moreover, von Neumann's cybernetically-based concept of cellular automata, which models dynamic systems through cells and activates a cell if and only if a set number of its neighboring cells exceeds some predetermined threshold, makes a copy of its initial configuration of cells and has been successfully used to model neurons and the complex actions that occur because of their wirings, like learning (Ilachinski 275; Wolfram 1179). The most important efforts of neurocybernetics come from Wiener's original postulations on the cybernetic use of prosthetics, however. As Wiener stated at the 1962 neurocybernetics symposium, "cybernetics is not only the study of control and communication in man and machine, but also between man and machine" (Wiener,

"Neurocybernetics" 2). Brain/machine neural interfaces use cybernetic properties to translate human signals into machine signals, and vice-versa. Neural interfaces "read out electrical activity from the nervous system, with the aim of decoding the signal with computational methods into cognitive, sensory, or motor information" ("Return of Cybernetics"). This development has led to such advances as tetraplegic people being able to control robot arms/hands and blind since birth people seeing enough to drive (Dobelle; Segal et al.).

Going a little further concerning the neural interfaces between animal and machine, cybernetics lets animals and machines not only communicate with each other in the context of prosthetics, but also merge into one unified being. The term "Cyborg" comes from the term "Cybernetic Organism," coined in 1960, which refers to a being that "deliberately incorporates exogenous components [to extend its] self-regulatory control function in order to adapt it to new environments," or, in other words, an enhanced human or animal just like the ones that have been discussed above (Clynes and Kline 27). Although prosthetics are probably not thought of when the word "cyborg" gets tossed around, they do create human cyborgs. Perhaps more obvious examples in lower animals will help: neurocybernetic insect/cyborg models have already been created that merge the neural flesh of insects and electric metal of microprobes. Microprobes have been inserted into insects during metamorphic growth cycles so that they emerge with the insect and develop directly in their tissue as one cybernetic organism (Bozkurt et al.). More recently and jarring, however, is Elon Musk's vision of Neuralink and the aim of achieving human symbiosis with AI to keep pace with the supposedly existential threat it poses, which would create science-fiction human cyborgs both in body and mind ("Return of Cybernetics").

Neuroscience has greatly benefited from cybernetics because of its concept of feedback loops. Much research has been devoted to the hopeful near-future application of deep brain

stimulation utilizing closed-loop feedback methods for ailments like Parkinson's that would not only read pathologic neural activity but also provide electrical stimulation to assuage it in real time (Bouthour et al.). Moreover, general knowledge of neuroscience has been greatly improved because of cybernetics. The biophysical basis of the neuronal action potential – which propagates the neural signal – is possible only because of voltage-gated ion channels, which create positive feedback loops in the neuron (Finger 404). The point of feedback loops, especially in the context of the neuronal action potential, will be revisited in the next chapter, on neuroscience.

Cybernetics is an interdisciplinary field of study that reaches into almost every other established discipline. Cybernetics and its implications of intelligent sensing, processing, reacting, acting, and re-inputting can be applied to any system to elucidate its design, function, and regulation. Moreover, the cybernetic concept of feedback not only combines informatic and thermodynamic entropy (like Maxwell's Demon), but also derives a method of creating automated AI. This theory of AI feedback has been applied to computational/digital models for the purpose of creating more intelligent machines. However, Wiener stressed the interplay between the human/animal and the machine when discussing the control and communicative implications of cybernetics, and therefore the still fast advancing study of neuroscience has been impacted by cybernetics. When stressing the parallel between life and machine, Wiener almost always looked through the lens of neuroscience, as the electrical impulses of nerves/neurons were the most logical comparison to make to the electrical impulses of machines. From computational network models to neuroprosthetics/cyborgs to the closed feedback loops of neurons, neuroscience and cybernetics go hand in hand. Thus, the symbiosis between man and machine and their constant fight against the second law of thermodynamics is nowhere better represented than in the neuron and its network, as will be discussed next.

Chapter Three: Mid-20th Century Neuroscience

When Norbert Wiener stated "that the physical functioning of the living individual and the operation of some of the newer communication machines are precisely parallel in their analogous attempts to control entropy through feedback,"[8] he might as well have been talking about neurons (Wiener, *Human* 26). Biological beings naturally decrease entropy – are enclaves of order – because of their feedback mechanisms. This phenomenon is also characteristic of machines, which is why Wiener claims that both entities are "living" in the sense that they resist the ever-rising tide of entropy. Neurons are the perfect cybernetic structure in that they achieve both biological and machinic negentropy.

Neurons are biological constructs and thus naturally decrease entropy. Furthermore, neurons need to decrease information entropy to send their messages correctly. The method utilized by neurons to shuttle this information is electrical. Therefore, neurons wield a machinic element to communicate and decrease entropy. Neurons include the negentropic feedback mechanisms of both man and machine in one entity, the action potential (Barnett and Larkman 197). When one considers that the neuron and its action potential incorporate all the entropic and informatic themes that Pynchon discusses in his works as well as a complete characterization of cybernetics, the full significance of its symbolism comes to a head.

This short return to Norbert Wiener's cybernetics serves as a topical bridge to discuss the neuroscientific technicalities of the neuronal action potential in depth. In 1952, Alan Hodgkin and Andrew Huxley, two English physiologists, quantitatively elucidated the propagation of the neuronal action potential. The action potential describes how the neuron communicates

[8] This quotation was also used in the previous cybernetics chapter when discussing the negentropic parallel between man and machine in their feedback mechanisms.

information by electrical and chemical means. The neuron conducts the action potential down its axon, a long tail-like projection off the neuron's body, or soma, to the axon terminal, the part of the axon that communicates with other neurons' dendrites (Hodgkin and Huxley 500; "Axon"; "Axon Terminal"). Dendrites are appendages of the neuron that receive signals from other neurons' axon terminals and similar conducting structures ("Dendrite"). Therefore, neurons receive information from other neurons through their dendrites, conduct it down their axons to the axon terminal, and then communicate this information to the dendrites of all the neurons to which *they* relate. All neurons in the body can communicate with all other neurons in the body through a system of axons and dendrites. These assemblies of neurons act together to perform all mental, physiological, autonomic, and muscular phenomena in the body (Chen and Lui).

Hodgkin and Huxley mathematically described the action potential using voltage clamps, a device used to measure ion currents through electrical cell membranes like neurons by "clamping" the cell to a certain voltage ("Voltage Clamp"). Hodgkin and Huxley performed the voltage clamp technique on the squid giant axon because its large size made it easier to record from ("Squid Giant Axon"). From this voltage clamp research, Hodgkin and Huxley were able to mathematically explain the mechanism of the electrical action potential through the dependence of the axonal membrane's permeability to charged sodium and potassium ion flow over time. This research was the first time electrical and chemical changes across the neuronal membrane were recorded and consequently shown to mediate the generation and propagation of the neuronal action potential.

The neuron communicates its electrical information through the utilization of cybernetic *feedback loops*. Norbert Wiener founded cybernetics as a field in 1948, and the neuronal action potential was elucidated by Hodgkin and Huxley in 1952. They found that the neuronal

membrane is permeable to the flow of charged ions through discrete voltage-gated ion channels. These voltage-gated ion channels open and close to let charged ions flow through the membrane based on the membrane potential, or the difference in electrical potential between the interior and exterior of the neuron ("Membrane Potential"). Voltage-gated ion channels produce and propagate action potentials because of feedback loops. The membrane potential of the axon controls the state of the ion channels (open or closed) so that they let in charged ions or not, which then changes the membrane potential again in a real-time feedback loop. The membrane potential of the neuron is normally low, about -70 mV: that is, there are normally more negatively charged ions inside the neuron than outside. If excitatory neurotransmitters bind to a neuron's dendrites, they can produce an electrical depolarization in the neuron that travels down its soma and axon. If the membrane potential rises through a propagated electrical depolarization, the inside of the neuron becomes more positive. If the inside of the neuron becomes sufficiently more positive, ion channels will open to let in positively charged sodium ions, which raises the membrane potential even more to explosively produce an action potential down an axon. The depolarization of the membrane potential affects the neuron's permeability through discrete ion channels, which then further affects the membrane potential through positively charged sodium ions rushing in to create an action potential if a threshold of depolarization is subsequently reached. This process of electrical depolarization and sodium ion channel opening is called the rising phase of the action potential. When the neuronal action potential successfully explodes down a segment of axon and peaks in membrane depolarization, the neuronal membrane potential then repolarizes back to its more negative resting state through the opening of potassium ion channels. Potassium ion channels initiate the falling phase of the action potential by letting out positively charged potassium ions from the neuronal axon

membrane and thus repolarizing the membrane potential to a negative refractory state in which that segment of axon cannot fire an action potential anymore. Soon afterward, however, the potassium ion channels close as well, and the membrane potential depolarizes a little more and returns to its normal resting potential to be ready to receive a depolarizing action potential again. The action potential "jumps" down the axon through this method, eventually reaching the terminus of the axon, where it excites the axon terminal to release neurotransmitters to other neurons' dendrites. This release of neurotransmitters across the synaptic cleft from axon to dendrite communicates one neuron's information to another, and therefore starts the entire action potential process over again ("The Action Potential"; Chen and Lui). Feedback loops, therefore, cybernetically channel the information of the action potential.

The neuronal action potential utilizes cybernetic feedback loops to decrease its electrical information entropy and communicate more cogently. These neuronal action potential feedback loops are vital to the concept of cybernetics and neuroscience, as both fields concern the correct communication of information for the successful functioning of a system (whether it be machinic or biological). Both man and machine regulate their systems and operate day to day through the communication that electricity performs in its negentropic feedback loops. If feedback loops were not employed, the information of electricity could not be correctly channeled by man or machine, and their entire system would soon shut down. Nervous systems of the biological construct and the machinic construct are thus the same in their shared values of electricity as information energy. In this way, Wiener was correct: man and machine are one.

Neuronal feedback loops are expressed not only in single neurons and their electric action potential activity, but also in entire assemblies of neurons firing together. Neural oscillations, rhythmic and/or repetitive patterns of massed neural activity in the central nervous system,

generally fire correctly through feedback connections (Bauer et al. 397; Wang). For instance and with great relevance to *Lot 49*, seizures happen when the feedback mechanisms supporting these patterns go haywire and the neurons abnormally and excessively fire in synchronous activity (Gloor 213). One of the culprits of a seizure attack is a reduction in the efficacy of the inhibitory neurotransmitter GABA (Treiman 8). When inhibitory neurotransmitters like GABA, which normally hyperpolarize neurons to cause them not to fire, are reduced, neural oscillations consequently fire too much as they have nothing to stop them; there are no longer any inhibitory neurotransmitters like GABA to counter the excitatory neurotransmitters like glutamate. In other words, the neural assemblies communicate too much information to each other, raising the brain's information entropy. Information entropy is at a maximum with this excess of neuronal firing, and, consequently, a seizure occurs.

Seizure research experienced a renaissance in the mid-20th century. In 1946, six years before Hodgkin and Huxley modeled the neuronal action potential, the American EEG Society was founded (now the American Clinical Neurophysiology Society) ("History"). In 1947, the first microelectrode was developed by physiologists Gilbert Ling, Ralph Gerard, and Judith Graham; the same microelectrode that Hodgkin and Huxley would use in 1952 (Edwards 44). EEG (electroencephalogram) is a noninvasive method of monitoring mass electrical brain activity (neuronal activity) by placing electrodes along the scalp ("Electroencephalography"). Microelectrodes can record local field potentials (LFPs), which are the summed electrical activity of all the neurons around the electrode and the signals they generate ("Local Field Potential"). Therefore, EEG and LFP both record neural oscillations. EEG and LFP data are subsequently vital to the understanding of seizures, as they result from assemblies of neurons firing electrical activity abnormally. Thus, with more advanced methods of recording EEG and

LFP data, comes a much fuller understanding of epilepsy. Consequently, epileptic seizure research procured novel discoveries in the mid-20th century. For instance, neurosurgeon Wilder Penfield invented the "Montréal Procedure" in the early to mid-20th century, which utilized EEG and electrodes to probe the epileptic patient's brain to more accurately target areas of their neural tissue responsible for seizure, which he then later destroyed in surgery (Ladino et al. 157-158).

Thomas Pynchon, in the introduction to his short story collection *Slow Learner*, says that he "happened to read Norbert Wiener's *The Human Use of Human Beings*" around the time he wrote his short story "Entropy," the thermodynamic, information theory, and neuroscientific aspects of which will be discussed in the next chapter (Pynchon, *Slow Learner* 13). Therefore, Thomas Pynchon knew and was influenced by Wiener's cybernetics, which also influenced neuroscience and the neuronal action potential. Although it has not yet been clarified that just because Wiener influenced neuroscience and Pynchon, neuroscience would necessarily also influence Pynchon, this thesis provides evidence that this claim is true.

Chapter Four: Thomas Pynchon and "Entropy"

Thomas Pynchon is a novelist most notable for his sprawling encyclopedic works filled with intricate prose. Pynchon is often cited as the preeminent postmodern author, with his 760-page genre-defining work *Gravity's Rainbow* (Pöhlmann 1). Pynchon is infamous for his reclusive behavior; he refuses to talk to reporters; there is hardly a picture of him in circulation; and he has not written any autobiographic statements, barring an introduction he wrote for his short story collection, *Slow Learner* ("A literary recluse"). What is known about Pynchon comes largely from his early life, decades in the past. Literary critic John Krafft, in *The Cambridge Companion to Thomas Pynchon*, has compiled one of the best biographies of Pynchon, pieced together with the few facts that are verifiable. Pynchon was born in Glen Cove, New York, in 1937. He attended Cornell University in 1953 at the age of 16 on a scholarship to study engineering physics. He soon switched his major to English, however, right before enlisting in the U.S. Navy his sophomore year. After serving for two years, Pynchon returned to Cornell to complete his B.A. in English with honors in 1959. A long-persistent rumor about Pynchon is that he took a class taught by Vladimir Nabokov, then a professor at Cornell. This rumor has never been verified, although it is obvious that Pynchon took much inspiration from Nabokov's works, especially his magnum opus, *Lolita,* in *Lot 49.* Later in his Cornell career, Pynchon began to write his first short stories, which were published in journals in 1959-1961. After graduating, he worked as a technical writer for Boeing in Seattle from 1960-1962, following a short stint in Greenwich Village. While working at Boeing, Pynchon worked on *V.*, which he soon published in 1963 along with various other short stories and technical missile write-ups. Pynchon quit Boeing, however, and soon moved to southern California until the 1970's, where he wrote such iconic works as *The Crying of Lot 49* and *Gravity's Rainbow.* As of now, Pynchon is thought to

reside in New York City; he is just as secretive with his behavior as ever, although recently he has gotten more lax with his "appearances," having a cameo on *The Simpsons* and narrating a trailer for the movie based on his novel *Inherent Vice* (Krafft 9-14; Pynchon, *Slow Learner* 3-4).

Pynchon's 1960 short story, "Entropy," a winner of that year's *Best American Short Stories*, sets the stage for some of Pynchon's science and technology themes, especially the ones present in *The Crying of Lot 49* (Foley and Burnett). "Entropy"[9] is the first work to introduce the scientific concept that Pynchon would soon become infamous for utilizing. Elucidating "Entropy" first will make the thermodynamic, informatic, and cybernetic themes in *Lot 49* more understandable, where they are applied in a more complex way. Consequently, *Lot 49*'s use of neuroscience will be much more easily understood as well.

"Entropy" concerns two apartments in Washington D.C., one on top of the other. In the upstairs apartment, neurotic Callisto is nursing a small bird "gently between his hands, against his body" in a "hothouse jungle" that is "hermetically sealed… a tiny enclave of regularity in the city's chaos, alien to the vagaries of weather, of national politics, of any civil disorder" (Pynchon, *Slow Learner*[10] 81-84). Callisto and his partner Aubade have created a sealed fortress against what Callisto deems as the inevitable heat death. It has been 37 degrees outside, the temperature of the human body in Celsius, for three days now, and Callisto is worried that his heat death anxieties are coming true (Pynchon, *Slow Learner* 13). Callisto previously learned about "Gibbs' notion of the universe… [a] spindly maze of equations [that] became, for him, a vision of ultimate, cosmic heat-death," and "the theorem of Clausius, which states that the

[9] "Entropy" is named "Entropy" for a reason. Remember: entropy, as per the second law of thermodynamics, constantly increases in an isolated system. A system naturally progresses from order to disorder as useful energy is extracted and made unavailable; a process that occurs in the system until maximum disorder, or heat death, is reached.

[10] *Slow Learner* is Pynchon's short story collection that "Entropy" is in.

entropy of an isolated system always continually increases" (Pynchon, *Slow Learner* 87). Once Bolzmann and others introduced the properties of statistical mechanics to the second law, Callisto realizes "that the isolated system – galaxy, engine, human being, culture, whatever – must evolve spontaneously toward the Condition of the More Probable" (Pynchon, *Slow Learner* 87). Callisto intellectually fears the concept of ever-rising entropy:

> [Callisto] found in entropy or the measure of disorganization for a closed system an adequate metaphor to apply to certain phenomena in his own world. He saw, for example, the younger generation responding to Madison Avenue with the same spleen his own had once reserved for Wall Street: and in American "consumerism" discovered a similar tendency from the least to the most probable, from differentiation to sameness, from ordered individuality to a kind of chaos. He found himself, in short, restating Gibb's prediction in social terms, and envisioned a heat-death for his culture in which ideas, like heat-energy, would no longer be transferred, since each point in it would ultimately have the same quantity of energy; and intellectual motion would, accordingly, cease. (Pynchon, *Slow Learner* 88-89)

Callisto metaphorically applies the second law of thermodynamics to culture and society, particularly American culture and society. He concludes that intellectual ideas will soon reach a point of entropic sameness and no longer have the energy reserves to be exchanged between people. Callisto blames this conversion of individuality to sameness on consumerism, as per literary critic Steve Vine's words:

> Callisto believes that the levelling or 'heat-death' of his culture will occur through the encroachment of the shopping malls and advertising businesses of Madison Avenue on the totality of American life, with the result that everything will be reduced entropically

> to its rule: thus the improbable, differentiation, individuality, ideas and "intellectual motion" will be banished from the "closed system"[11] of America, as capital assumes all to itself. (Vine 163)

American capitalism creates an isolated system that is sealed off from infusions of outside energy and creates sameness where difference once existed through the dominance of capital wealth. Callisto predicts the heat death of society through the encroachment of late-stage capitalism, where everything is under the thumb of corporations and people are homogenized into one kind of consumer to better make them money. As the infringement of shopping malls, fast food restaurants, and corporate industries becomes more and more intense, the entropy of Callisto's universe increases towards his cultural heat death. Soon, Callisto believes, intellectual motion will all but stop, and exchange of ideas will be impossible. That is the near future that Callisto is so fearful of seeing and that he is attempting to contest with all his resources.

Callisto has devoted his middle age to fending off this supposed rise in entropy he so fears, a rise that does seem to be escalating in the past few days. Callisto's partner Aubade hears "the chatter of birds and fitful car honkings scattered along the wet morning and Earl Bostic's alto rising in occasional wild peaks through the floor," which causes "the architectonic purity of her world [to be] constantly threatened by… hints of anarchy" (Pynchon, *Slow Learner* 88). Aubade must "continually readjust [her world] lest the whole structure shiver into a disarray of discrete and meaningless signals" (Pynchon, *Slow Learner* 88). Aubade performs this process through cybernetic feedback; indeed, they are attempting to achieve an "enclave" of negentropy. Callisto understands Aubade's readjusting against hints of anarchy "as a kind of feedback,"

[11] Scholars and even Pynchon himself often misuse "closed system" to mean "isolated system."

almost exactly quoting Wiener in *The Human Use of Human Beings* (Pynchon, *Slow Learner* 88). Constantly enacting feedback mechanisms in a futile attempt to fight entropy and keep order has caused Aubade to crawl "into dreams each night with a sense of exhaustion, and a desperate resolve never to relax [her] vigilance" (Pynchon, *Slow Learner* 88). The entropy continues to rise as Aubade's feedback attempts prove worthless and Callisto gets more and more fearful.

The main issue Callisto seems to have overlooked is that by hermetically sealing himself away, he creates an isolated system. In an isolated system, entropy will always rise to a maximum until heat death occurs. Aubade attempts to act as Maxwell's Demon and reverse this rise in entropy, but, as we know, Maxwell's Demon is an impossibility in an isolated system, and Aubade's attempts are as futile as the Demon's. Infusions of energy from an outside source are needed to keep an isolated system "running" and orderly, and Callisto has prevented that from occurring. What Callisto views happening to America is also happening to his hothouse. Aubade wanders through "the ashes of her own lovely world" as "the temperature held steady" and "the faint rhythm inside the bird begin[s] to slacken and fail" (Pynchon, *Slow Learner* 97). The bird's heartbeat eventually ticks "a graceful diminuendo down at last into stillness" as "the warmth of [Callisto's] body" fails to communicate life back into the bird (Pynchon, *Slow Learner* 97). Callisto all at once realizes that if the transfer of heat ceased to work between him and the bird, then that would mean they are in an entropic medium of heat death. Callisto's worst fears have come true in his apartment, and entirely by his own paranoid volition. Aubade, too, realizes what they have done. Aubade understands that her feedback efforts were useless simply because they were in an isolated system, and moreover may have even increased the entropy of their apartment. Thus, as the temperature is still 37, Aubade moves "swiftly to the window before Callisto could speak" and smashes "out the glass with two exquisite hands" to await the

"moment of equilibrium… when 37 degrees Fahrenheit should prevail both outside and inside, and forever" (Pynchon, *Slow Learner* 98). Aubade and Callisto now fear the "tonic of darkness" and "final absence of all motion" that comes with their heat death apocalypse by breaking their hothouse window (Pynchon, *Slow Learner* 98).

Of course, this result is not the true consequence of Aubade breaking their window. Although perhaps in the heat death future that Callisto envisions, their hothouse apartment melding with the outside world would mean the entropic fusion of the two once separated worlds all into 37 degrees Fahrenheit, the more immediate result of Aubade breaking their window is negentropy, or order. Callisto and Aubade's apartment, existing on a much smaller scale than the universe, would reach its own heat death much faster than the world outside. It seems as if their apartment had even already reached its heat death as the transfer of energy between Callisto and the bird failed. What is needed is an infusion of new energy into their isolated apartment system to create differentiation and order. Aubade provides this infusion of energy when she breaks their window and the outside energy of the world suddenly rushes into their once isolated system to bring difference where there was once only sameness, order where there was once only disorder. Aubade contests the entropic heat death of their world through the notion of outside entropy of which they are so naively fearful, instead bringing in external energy to a once isolated system.

Alternatively, in the downstairs apartment, Meatball Mulligan is throwing a party "moving into its 40th hour" (Pynchon, *Slow Learner* 81). In this downstairs apartment, another definition of entropy is displayed, separate yet connected to Callisto and Aubade's version. The party, as we are introduced to it, seems to be in a lull. Partygoers "Sandor Rojas and three friends" are "staying awake on Heidseck and Benzedrine pills," while "in the living room Duke, Vincent, Krinkles, and Paco sat crouched over a 15-inch speaker… [smoking] an adulterated

form of *cannabis sativa*" (Pynchon, *Slow Learner* 81). There are "several government girls… passed out on couches, chairs, and in one case the bathroom sink," while party host "Meatball himself was sleeping by the window, holding an empty magnum to his chest as if it were a teddy bear" (Pynchon, *Slow Learner* 81-82). Meatball's party seems as if it has exhausted itself: that its system is also reaching an entropically stable point as all usable energy of the partygoers dissipates into fatigue. Meatball's party entropically mirrors Callisto and Aubade's hothouse in the fact that both systems seem to have reached maximum heat death disorder where everything is the same and nothing is happening. The main difference here, of course, is the fact that Meatball's heat death occurs at the start of his apartment's story, while Callisto and Aubade's heat death occurs at the end of their apartment's story. However, not all is what it at first seems in Meatball's apartment system. It is not in high in entropy at all.

Pynchon is attempting another definition of entropy in the downstairs apartment; the entropy also rises at Meatball's party, just as it does for Callisto and Aubade. "Meatball's party seemed to be gathering its second wind" as "the last bass notes of *Heroes' Gate*" boom up through the floor and wake "Callisto from an uneasy sleep," presenting – significantly – that their hothouse is not completely sealed (Pynchon, *Slow Learner* 82-83). Meatball is then "hurled wincing into consciousness" from a cymbal crash as his friends speak nonsense lingo to him (Pynchon, *Slow Learner* 85). Soon afterward, Meatball's friend Saul appears "out on the fire escape, raking his fingernails down the windowpane" as "three coeds from George Washington" barge in the front door "each holding a gallon of Chianti" (Pynchon, *Slow Learner* 86). The party seems to be getting more and more chaotic and disordered, especially when the already bustling

party is "invaded by five enlisted personnel of the U.S. Navy," all looking for a "hoorhouse"[12] (Pynchon, *Slow Leaner* 92). At first glance, it seems that Pynchon has his definition of entropy incorrect. Because entropy is synonymous with chaos and disorder, it is often misconstrued with hectic scenes like large, energetic crowds. As the party gets more and more frenzied, the "entropy" goes up in this sense of the definition as the chaos increases. As we know, however, entropy is not equal to disorder and chaos in the conventional meaning of the words, but rather equal to disorder in the sense of degradation of energy into uniformity, where everything is bland, dispersed, and inert. With this thermodynamic definition in mind, Meatball's party is actually *losing* entropy as more and more differentiation and energy gets added to his apartment and partygoers become more packed together and thus orderly.

Literary critic David Seed claims that Meatball Mulligan's party exemplifies another side of the thermodynamic definition of entropy, the quantity of energy in a system unavailable to perform mechanical work. Seed explains that "apart from social ironies the party dramatizes one strand of meaning in 'entropy,' namely that it measures the amount of energy unavailable for conversion to work in a system" (145). Although Seed is correct that there is a lot of energy at the party, and although he is also correct that entropy increases as energy becomes unavailable for conversion into work, it does not make sense that the partygoers' energy would be energy unusable to do work. There is nothing to specify that the partygoers' energy sources are unable to be utilized in "Entropy," and Seed himself does not elaborate past this sweeping statement. This statement of available/unavailable partygoer energy is nebulous; what would that energy, when used, look like? For the partygoer's energy to be truly unavailable for conversion to work,

[12] If the sailors were mixing up *hoorhouse* with *hothouse*, then they meant to visit the apartment directly above them.

it would have to already have been used previously, of which there is no suggestion. Seed falls back on a contrary definition of entropy, conflating entropy with differentiation, change, and structure as he claims that as "other guests arrive and add to the bustle... The disorder and noise reaches a climax where we could also say that the entropy within the party has approached its maximum" (145). Seed has, in effect, confused himself because of the enigmatic definition of entropy and the second law. Unlike Callisto's hothouse, Meatball's apartment is not an isolated system. People come through the windows and doors frequently, infusing more and more external energy into the open system so that it keeps bouncing and does not tend toward a thermodynamically entropic maximum, as would an isolated system. The partygoers keep the party churning away from an entropic equilibrium as they continue to bring in energy from outside; although the party is "disordered" in the dictionary sense, it is not in the thermodynamic one. Considering this fact, how does the entropy in Meatball's apartment increase, especially if it exemplifies an open system? Meatball's apartment increases in entropy not thermodynamically, but informatically.

As the party ramps up in excitement, miscommunication and signal noise run amok. Saul enters the apartment, speaking about how he just recently split from his wife over an argument about information theory. Saul's wife, Miriam, was bothered by "this idea of computers acting like people," and Saul "made the mistake of saying you can just as well turn that around and talk about human behavior like a program fed into an IBM machine"[13] (Pynchon, *Slow Learner* 90). When Saul told this to Miriam, "she hit the roof" in anger, and they started to fight (Pynchon,

[13] This quotation was also referenced in the cybernetics chapter concerning cybernetics' impact on AI.

Slow Learner 90). Saul has no idea why Miriam got so angered at his counterargument, explaining that "a kind of leakage" caused their miscommunication:

> Tell a girl: "I love you." No trouble with two-thirds of that, it's a closed circuit. Just you and she. But that nasty four-letter word in the middle, *that's* the one you have to look out for. Ambiguity. Redundance.[14] Irrelevance, even. Leakage. All this is noise. Noise screws up your signal, makes for disorganization in the circuit. (Pynchon, *Slow Learner* 90-91).

Even if one disregards the fact that the argument that Saul and Miriam were having was a direct reference to cybernetics and the parallel between mechanical and biological "life" and their anti-entropic processes of control and communication, Saul's conundrum channels Shannon and Wiener. The information entropy – or uncertainty – of Saul's statement to Miriam was too high, and consequently she misunderstood the meaning of Saul's message in her reconstruction of it. Saul's example, that the word "love" carries too much ambiguity and/or noise, bolsters this hypothesis. Love is a complex word loaded with meaning and thus information potential; it means something different to almost everyone on Earth. Therefore, "love" has too much information entropy in its word, too much uncertainty of its actual meaning. Leakage can occur because of the word "love," creating noise in the transmitter's message and the receiver to easily misunderstand what the sender means by its transfer.

Saul's quarrel with his wife sets the stage for the rest of Meatball's party. After hearing Saul's story, Meatball claims that "most of the things we say, I guess, are mostly noise" (Pynchon, *Slow Learner* 90). Meatball and Saul's conversation devolves into a medium of

[14] Pynchon here seems to get confused. As we know, redundancy decreases information entropy, making sure that the message can better get across a channel from transmitter to receiver without fatal corruption. Ambiguity, irrelevance, and leakage all increase the noise of a signal, but redundancy is negentropic in that it *decreases* the noise of a signal. Following Pynchon's confusion, many literature scholars have mistakenly thought redundancy beneficial to noise, much as they confuse closed and isolated systems.

communication too entropic to carry on talking, until Saul eventually says, "The hell with it… I'll take that drink," ending their useless discussion immediately (Pynchon, *Slow Learner* 90). Around Saul and Meatball, the conversations are turning increasingly more absurd as excess noise is added to their messages and uncertainty rises. Miscommunication runs rampant as the explanation for each sender's message grows manifold. Krinkles is "engaged in amorous conversation" with one of the GW coeds, claiming that he cannot put his friend Dave down because of an accident he suffered while in the army when "he was handling hot stuff one day and got an overdose of radiation. So now he's got to wear lead gloves all the time," to which the coed shakes her head sympathetically and exclaims "what an awful break for a piano-player" (Pynchon, *Slow Learner* 92). This conversation occurs directly before the sailors charge into Meatball's apartment, screaming about whorehouses. Absurd conversations keep building upon each other as the communication entropy continually increases and "noise" gets added to their circuits. Soon afterward, the sailors and coeds from George Washington are "singing Let's All Go Down and Piss on the Forrestal" as a "two-handed, bilingual *morra* game" is being played by the fridge (Pynchon, *Slow Learner* 96). A fight breaks out between the sailors as the *morra* players keep competing, "screaming *trois, sette* at the tops of their lungs" while a girl that Meatball recently placed in the shower to wake up starts to shout that "she was drowning" from sitting on the drain too long (Pynchon, *Slow Learner* 96). All this commotion leads to "the noise in Meatball's apartment" to reach a "sustained, ungodly, crescendo" (Pynchon, *Slow Learner* 96). The information entropy of Meatball's party has hit its maximum, just as the thermodynamic entropy did for Callisto above.

Unlike with other disturbances, Callisto and Aubade's apartment is not impervious to the huge sounds emanating from Meatball's roaring party as a noise from downstairs, "a girl's

scream, an overturned chair, a glass dropped on the floor, [Callisto] would never know what exactly… pierce[s] that private time warp" of their hothouse apartment and makes Callisto realize that the bird he is cradling is dying (Pynchon, *Slow Learner* 97). This noise interruption has major consequences for Callisto and Aubade's heat death and its eventual negentropic break into order, as Callisto comprehending that his bird is dying immediately leads Aubade to smash their apartment window.

Meatball, while idly scratching his stomach, finally decides to act and reduce the information entropy in his apartment. Meatball, in his mind, has two options:

> "(a) lock himself in the closet and maybe eventually they would all go away, or
>
> (b) try to calm everybody down, one by one" (Pynchon, *Slow Learner* 96).

Meatball chooses option (b), electing it as the more logical choice in the long run perhaps because he intuitively understands that it would decrease noise entropy as opposed to option (a), which would most likely let the party slip into an informatic heat death where there is only noise. Meatball decides to "try and keep his lease-breaking party from deteriorating into total chaos" as he gives wine to the sailors, separates the *morra* players, helps the girl out of the shower, calms down Saul, and calls a repairman for the now-breaking refrigerator[15] (Pynchon, *Slow Learner* 97). Meatball enacts these decisions "until nightfall, when most of the revelers had passed out and the party trembled on the threshold of its third day" (Pynchon, *Slow Learner* 97). Meatball decreases the information entropy of his party by acting as a Maxwell's Demon and sorting everyone out into their respective places.[16] Moreover, it can also be seen that Meatball applies

[15] Fixing the refrigerator would help it correctly decrease entropy again!
[16] Meatball as Maxwell's Demon works as opposed to Aubade as Maxwell's Demon because Meatball is in an *open* not *isolated* system.

the cybernetic concept of feedback to reduce the entropy in his apartment. He receives stimuli from the partygoers, processes said information, and then acts on information to decrease the information entropy of the partygoers and better update his future negentropic actions. Meatball, like a cybernetic system, constantly changes his environment and then adapts to said environmental changes through intelligent processing and response to information in a *closed feedback loop* that consists of Meatball, the partygoers, and both entities' actions. Therefore, like Callisto's apartment at the end of the story, Meatball's apartment rises to an entropic maximum before finally decreasing in entropy when it peaks; the only difference is the type of entropy rising. In the future, however, the entropy of both apartments could very well still rise again.

Finally, the rising information entropy of Meatball's apartment becomes the catalyst that breaks the thermodynamic heat death of Callisto's upstairs hothouse. Although Aubade believes that the sounds of "Earl Bostic's alto rising in occasional wild peaks through the floor" is disrupting her "architectonic purity" and increasing entropy, it is in reality attempting inklings of the opposite (Pynchon, *Slow Learner* 88). Remember: a truly isolated system is virtually impossible in practice, a fact that is true even for Callisto and Aubade's meticulously constructed hothouse. These interjections of noise from Meatball's screeching party act as endeavored infusions of outside energy in Callisto's apartment, fighting entropy and providing new order and energy to be utilized. Callisto wakes up in the first place because of "the last bass notes of *The Heroes' Gate*… [booming] through the floor," and, moreover, "something from downstairs – a girl's scream, an overturned chair, a glass dropped on the floor, [Callisto] would never know what exactly" sonically rising through the floor is the first domino in the reaction that eventually leads Aubade to smash their hothouse window and restore order (Pynchon, *Slow Learner* 83; 97). The beginning and ending scenes of Callisto's hothouse concern the rising noise from Meatball's

downstairs party. Since Callisto's apartment seems to be a successfully sealed hothouse and thus is virtually isolated as a system, these noise interjections do little. Especially when considering the fact that Aubade performs a corrupted form of feedback on the noises, which only serves to further increase entropy, Callisto's hothouse largely retains its energetic impenetrability.[17] Still, 100% isolated systems are impossible in practice, and some noise from Meatball's party does manage to infiltrate the hothouse. This small leakage of noise also causes a small amount of order, or otherwise Callisto and Aubade would not be able to hear Meatball's party in the first place. Order is synonymous with usable energy, and usable energy with successful information transfer. To effectively transmit a message through a channel, the correct combination of noise disorder and information order is needed; a combination that the transmitted sound from Meatball's party provides. The small amounts of sound leaking from Meatball's apartment are still enough, then, to indirectly imbue the insight to Callisto that he is experiencing an isolated system's heat death through their energetic information transmission, and, consequently, agitates Aubade to break their window. Thus, it can be safely assumed that if it were not for Meatball's information "noise," Aubade would never have broken her and Callisto's hothouse heat death.

A small suggestion towards the interplay between neuroscience and cybernetics is, furthermore, present in "Entropy," foreshadowing the much greater emphasis the subjects will have in *Lot 49*. When Meatball first wakes up from the cymbal crash, he decides to cure his hangover by getting drunk again on tequila, thus "restoring order to his nervous system" (Pynchon, *Slow Learner* 85). Before Meatball can cybernetically reduce information entropy at his party, he must reduce the information entropy of his nervous system and neurons. Alcohol

[17] Aubade's mistake of increasing entropy in her attempts to decrease it contain much significance for Oedipa in *Lot 49*.

primarily exerts its effects by depressing the central nervous system. Alcohol performs this action by potentiating the efficacy of the main inhibitory neurotransmitter GABA by increasing the power of GABA's binding to its associated receptors. When GABA is potentiated, it decreases the likelihood of neurons producing action potentials; that is, it decreases the neuronal transfer of information. GABA performs this action mainly by channeling negatively charged chloride ions into the neuron (Lobo 90-91). More alcohol, more inhibition, less neuronal firing, less information. When neurons are sending less information to each other because of the impacts of GABA, that means the CNS possesses less information entropy, or noise. Remember, lower information equals higher certainty equals lower entropy. Through the effects of tequila, Meatball lowers his nervous system's information entropy by making his neurons fire less. Only then can Meatball feel confident enough to decrease the information entropy of the party, because he has already decreased the noise in his own mind's and body's system.[18]

"Entropy" serves as a concise introduction to the themes that will be explored in *Lot 49*. Information theory, thermodynamics, and cybernetics are much more thoroughly probed in *Lot 49* as Pynchon matures as an author. Still, Pynchon's theme of rising thermodynamic and information entropy and the attempt to fend them off through cybernetics and Maxwell's Demon remain central in *Lot 49,* no matter how much more complex the storyline and its literary implications. The next chapter will discuss Pynchon's multifaceted use of Maxwell's Demon, thermodynamics, information theory, and cybernetics in *Lot 49*, exemplifying how much his understanding and use of the scientific concepts evolved from "Entropy" to implicate neuroscience.

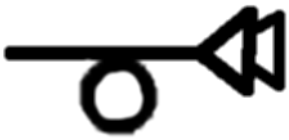
[18] Utilizing alcohol to decrease the nervous system's information entropy also has much significance to Oedipa and *Lot 49*.

Chapter Five: *The Crying of Lot 49* and Current Scholarship

The Crying of Lot 49 is Thomas Pynchon's second novel, published in 1966. Uncharacteristically short for a Pynchon novel, its ~150 pages are saturated with science and technology allusions. Moreover – like all of Pynchon's works – *Lot 49* is a divisive novel. Some critics laud its creativity as formative American literature, while others admonish it as shallow postmodern pandering (O'Donnell 6-8). Pynchon himself dislikes *Lot 49*, claiming that he seems "to have forgotten most of what I thought I'd learned up till then" (Pynchon, *Slow Learner* 22). More recently and up to the present day, however, *The Crying of Lot 49* has attracted significantly more positive scholarship and criticism as it has been revealed to be a much more complex and stand-alone novel than originally thought (O'Donnell 8-9). *Times Magazine* even proclaimed *Lot 49* as a top 100 best English-language novel published from 1923 to 2005 ("ALL-TIME 100 Novels"). *The Crying of Lot 49* is seen as a good introduction to Pynchon, probably because of its length, and consequently it is often taught in high school and college English classes (Schaub 1). *Lot 49* attracts many opinions and has had diverse impacts on American culture, complexities that are paralleled in the novel's literary content.

The Crying of Lot 49 centers on heroine Oedipa Maas from the fictional town of Kinneret, California, who is suddenly made the "executor, or she supposed executrix," of the estate of her late lover, Pierce Inverarity (Pynchon 1). Oedipa, who has been living a bland life as a middle-class housewife married to a radio jockey named Mucho Maas, is soon thrown into a global conspiracy concerning the mail and how it is delivered through postal services. Oedipa learns that Pierce Inveriarty owns virtually all of San Narciso, a fictional nearby California town. In order to better organize Pierce's estate, Oedipa drives to San Narciso to consult with Pierce's lawyer, Metzger. While in San Narciso, Oedipa meets, among many: The Paranoids, a teenage

Beatles-esque pop band; Randolph Driblette, a deranged theater director; John Nestafis, an inventor of a "working Maxwell's Demon;" and Genghis Cohen, a stamp collector. Always associated with these individuals appears a muted postal/post horn symbol along with the acronym "W.A.S.T.E." Soon, this symbol begins to propagate itself everywhere Oedipa turns, seeming to grace every nook and cranny of San Narciso, San Francisco, and, eventually, California. It surfaces that the muted post horn symbol and "W.A.S.T.E." both reference the Tristero/Trystero, an underground postal service made up of the "refuse" or "outsiders" of society. The Tristero system manifests itself in several different societies and groups as its existence, despite the proliferation of signs, becomes more tenuous. It is unknown whether Pierce knew about the Tristero, or even if the Tristero exist at all and Oedipa is simply being paranoid. Oedipa eventually surmises that either the Tristero exist, and it is a grand conspiracy that makes up not only Pierce's legacy and San Narciso but also the entire world, or she is simply insane, "assumed full circle into some paranoia" (Pynchon 151). At the end of the novel, Oedipa goes to a courtroom stamp auction selling stamps emblazoned with the muted post horn, to hopefully find out for herself whether the Tristero are real. Thus, *Lot 49* evades all notion of an ending or even any set facts; like Oedipa, the reader has no idea what is true and what is false, or if anything, concerning the Tristero or otherwise, is real. *Lot 49* gives no answers away, which, in itself, is the implicit takeaway that the book desires to impart to the reader.



The Muted Post Horn

Source: "Trystero Small." *Wikipedia*, 19 Jan. 2006, en.wikipedia.org/wiki/File:Trystero-small.png.

First and foremost, it is worth probing exactly *why* it would matter that there is a rival postal service undermining the federal system. Order is synonymous with usable energy, which is needed to perform sorting; sorting like Maxwell's Demon enacts. Postal systems *sort* mail everyday as part of their job; therefore, they need order, information, negentropy. However, there

is more significance to a conspiratorial postal service than just the metaphor of sorting. In the digital age, it can be hard to remember how much more important the mail was in the 1960's. Without email, texting, and cellular phones, mail was one of the primary means of communication. Furthermore, there was no DHL or FedEx, and UPS was just starting to establish itself as a nationally recognized company ("About Us: DHL"; "FedEx history"; "About UPS"). The main player in the communications and shipping game, unlike today, was the USPS. A seemingly sinister ulterior system revolting against the federal mail system was therefore a much bigger deal than it would be now. The Tristero as an entity against the federal system is not only unprecedented when considering there were no real established private systems, but also more malignant, as people have much more information to potentially lose in the Tristero's disruption of the USPS's communication. Information theory wise, the Tristero also possess much weight, as through their rival postal system it is unknown if they help increase or decrease information entropy. If they *increase* information entropy, as it seems they often do, then their presence in American life only serves to hurt other, law-abiding, citizens. The significance of the Tristero as rival mail service should thus be kept in mind throughout the rest of this thesis, as it contains key implications for everything else in *Lot 49*.[19]

A cornerstone reading of *Lot 49* was pioneered by scholar Anne Mangel in her 1972 article, "Maxwell's Demon, Entropy, Information: The Crying of Lot 49."[20] Mangel's article has spearheaded scholarship on *Lot 49*, being one of the first critical essays to contend that there is more to the work than meets the eye. Mangel's reading centers on a pivotal part of the novel,

[19] Most scholars (e.g. Edward Mendelson, Robert Watson, Thomas Schaub, James Nohrnberg, Annette Kolodny, Daniel Peters, etc.) see the Tristero as a beneficial force to Oedipa and her *Lot 49* universe because they inject change into her otherwise bland world. This thesis will go against the grain by arguing that the Tristero are largely malicious to Oedipa because of how much they increase information entropy for her and her nervous system.
[20] The title of Mangel's essay is eerily similar to Leff and Rex's influential book on Maxwell's Demon called *Maxwell's Demon: Entropy, Information, Computing*, which was published 18 years later in 1990.

when Oedipa discovers the concept of Maxwell's Demon. To better understand Mangel's work, we must thus first outline what occurs in this key section of *Lot* 49. Oedipa initially confronts Maxwell's Demon when she is walking around the Yoyodyne factory of San Narciso, which she went to "because she felt it might redeem her a little from inertia" on her quest to discover the legacies of Pierce and the Tristero (Pynchon 65). At Yoyodyne, Oedipa gets separated from the group she is in and wanders aimlessly around their office cubicles. Oedipa bumps into Yoyodyne engineer Stanley Koteks doodling the muted postal horn symbol, which immediately piques her interest. Oedipa acts as if she is a stockholder, which generates a conversation between her and Koteks. Koteks tells Oedipa that he is angry about signing away his patent rights to any invention he might come up with, because it "stifles your really creative engineer" (Pynchon 67). Koteks explains to Oedipa that he knows "somebody who still invents things," John Nestafis (Pynchon 68). Nestafis has built the "Nestafis Machine," which contains "an honest-to-God Maxwell's Demon" inside (Pynchon 68). The Nestafis Machine is a "box with a sketch of a bearded Victorian on its outside [Clerk Maxwell], and coming out of the top two pistons attached to a crankshaft and flywheel" (Pynchon 68). Koteks asserts that you simply "stare at the photo of Clerk Maxwell, and concentrate on which cylinder, right or left, you wanted the Demon to raise the temperature in. The air would expand and push a piston" (Pynchon 68-69). Moreover, Koteks claims that "Not everybody can work it, of course… only people with the gift. 'Sensitives,' John calls them" (Pynchon 69). Nestafis lives in Berkeley with his Nestafis Machine, and Koteks offers Oedipa the opportunity to visit him and try to power the invention. Oedipa complies, believing it to be a good lead on her Tristero investigation, an organization every day presenting itself as more and more dangerous to her well-being and, simultaneously, connected with Pierce.

Oedipa soon afterward travels to Berkley to consult with an English professor, Dr. Emory Bortz, at UC Berkley over a Tristero line variation she found in a play put on by Driblette, and furthermore to "take a look at how the inventor John Nestafis picked up his mail" (Pynchon 80). Oedipa visits John Nestafis in "a pseudo-Mexican apartment house," where he is busy watching TV (Pynchon 83). Nestafis wheels out his invention for Oedipa, explaining that there exist two kinds of entropy, "one having to do with heat-engines, the other to do with communication," and that "the two fields were entirely unconnected except at one point: Maxwell's Demon" (Pynchon 84).[21] Nestafis claims that "the Demon [in the Nestafis Machine] passes his data on to the sensitive, and the sensitive must reply in kind… The sensitive must receive that staggering set of energies, and feed back something like the same quantity of information. To keep it all cycling" (Pynchon 84-85). To Nestafis, "the Demon makes the metaphor [of entropy] not only verbally graceful, but also objectively true" (Pynchon 85). Nestafis lectures Oedipa to "Watch the picture… concentrate on a cylinder… [and] leave your mind open, receptive to the Demon's message" (Pynchon 85). Oedipa stares at the picture of Clerk Maxwell "through two Yogi Bears, one Magilla Gorilla and a Peter Potamus… waiting for the Demon to communicate" (Pynchon 85). The Demon, however, never sends a message, and the piston never moves. Entropy is not decreased, and Oedipa fails in her role as a sensitive. Nestafis tells Oedipa not to worry, because "the news will be on any minute. We can [have sex] there," seemingly used to failures like

[21] Nestafis seems to understand that the Demon cannot decrease entropy on its own. As Oedipa understands after Nestafis's lecture to her: "as the Demon sat and sorted his molecules into hot and cold, the system was said to lose entropy. But somehow the loss was offset by the information the Demon gained about what molecules were where" (Pynchon 84). This explanation on why Maxwell's Demon cannot decrease entropy comes straight from Norbert Wiener's thoughts in *The Human Use of Human Beings*. However, later Nestafis says that the Demon performs "one little movement, against all that massive complex of information, destroyed over and over with each power stroke," which instead references Szilard's refutation of the Demon and its need to continually "dump" degraded energy out of its brain system into its container (Pynchon 85). Therefore, Nestafis seems to know and understand both Szilard's and Wiener's refutation of the Demon. As will be discussed soon, Nestafis consequently builds his "Nestafis Machine" for use with a "sensitive" to get around these refutations.

Oedipa's (Pynchon 86). On hearing this statement, Oedipa immediately flees Nestafis's apartment and races to San Francisco for hoped mental respite. Although Oedipa never explicitly confronts the Demon again in *Lot 49*, it remains in her psyche for the rest of the novel as she uses its concepts as a metaphorical basis to comfort herself during her Tristero search.

The interactions that Oedipa has with Koteks and Nestafis, although brief when measured by how much space they take up in pages, are profoundly important for the context and understanding of the novel. Mangel was one of the first – and still one of the most important figures in Pynchon scholarship – to understand this fact. The thesis of Mangel's essay states that:

> Pynchon uses Maxwell's notion of the Demon as a metaphor for Oedipa's experiences. The frequent allusions to Oedipa's sorting masses of information evoke the idea of Maxwell's sorting Demon… the sorting and shuffling [concerning Pierce's estate] which is mentioned at the start of the novel is just the first indication of the separating Oedipa will have to do to create order out of the mass of clues, symbols, and signs which descend upon her… Her desire to bring order to the mass of confusing interests left by Inverarity leads her to the discovery of the 'Tristero'… [and] just as the Demon, by sorting the molecules, gains information about them, so Oedipa shuffles through countless people and places, gathering information about the elusive Tristero. (Mangel 88-90)

Mangel conflates thermodynamic and informatic sorting as Maxwell's Demon performs both simultaneously in its isolated chamber. Unlike in "Entropy," where the two definitions of entropy are contained in disparate apartments, Oedipa in *Lot 49* exemplifies both forms of entropy simultaneously because Oedipa is the Demon, and vice-versa. Oedipa sorts through masses of information left by Pierce and the Tristero attempting to decrease thermodynamic entropy just as the Demon sorts through masses of gas molecule information attempting to

decrease thermodynamic entropy. Critics after Mangel widely claim that as Oedipa goes through her quest, she goes from high to low thermodynamic entropy as she starts out at the beginning of the novel, "shuffling back through a fat deckful of days which seemed (wouldn't she be the first to admit it?) more or less identical," progressing as the novel develops toward a state of wild differentiation and variance as the Tristero impinge on her from all sides (Pynchon 3). Furthermore, critics claim that Oedipa advances from low to high information entropy, for much of the same reason: as Oedipa's Tristero quest evolves, she gains more and more Tristero information and subsequently, entropy (Kharpertian 104; Mendelson 128*).* This viewpoint is largely correct when looking from an "outside in," third-party spectator perspective at Oedipa's life as she moves throughout the novel in an *open system*. However, in the context of Oedipa as Demon in a container of gas (or Oedipa as a woman in the isolated system of California), both her thermodynamic and information entropy increase, as they are so intimately linked for the Demon. In the Demon's container, if information entropy goes up because of its improper sorting, then so does thermodynamic, and vice-versa. The sorting the Demon performs, remember, must eventually increase entropy by virtue of its mental faculties and peripheral sense organs. The consequence of this process is exactly what occurs with Oedipa.

Mangel realizes this conundrum herself as she states that Oedipa personifies "the Demon problem" concerning the paradox on why Maxwell's Demon does not actually violate the second law (Mangel 90). As "revelations which now seemed to be come crowding in exponentially, as if the more [Oedipa] collected the more would come to her" begin to overwhelm Oedipa, she realizes that her attempts to sort the information she obtains might only create more noise (Pynchon 64). Oedipa slowly understands that she will never obtain one set meaning for the Tristero, and that, rather, each "clue" is just adding noise entropy to her search through the

subsequent proliferation of yet more information she must elucidate. Remember: the entropy in the Demon's container will still always increase, because the negentropic sorting that the Demon achieves is offset by the entropic environment inherently needed for the Demon to see the gas particles in the first place. Mangel seizes on this fact when explaining that "just as the intricacies involved in the Demon's perception of the molecules actually increase the net entropy of the system, so Oedipa's perception of information actually increases the entropy, or disorder, around her" (Mangel 92). Oedipa's perception increases information entropy by far out-weighing in disorder any order she successfully creates through her sorting because, like the Demon, Oedipa is a participant intimately connected with the operation of the isolated system that contains her.

Nestafis also seems to have elucidated this fact about perception increasing the Demon's entropy and consciously built his Nestafis Machine around an apparent solution. Accordingly, "Nestafis seems to be aware that the Demon alone is not capable of violating the second law" (Grant 86). Another way of looking at the entropic increase that occurs because of the Demon's perception is via the "dumping" of information the Demon gains in its head (through its sense organs) about the molecules of gas. As we discussed in chapter one, the information entropy in the Demon's mind increases until it reaches a point where it cannot rise anymore. Eventually, the Demon must release this degraded information into the container, which will increase its overall entropy more than what was previously achieved by the Demon's negentropic sorting. When Nestafis says, "the sensitive must receive that staggering set of energies, and feed back something like the same quantity of information," he is speaking on exactly this problem (Pynchon 84-85). Oedipa, as sensitive, is the external entropy dump that the Demon in the Nestafis Machine uses. If the Demon in the Nestafis Machine dumps its perception/mental information entropy onto Oedipa, it increases the entropy of *her* instead of its container.

However, "the entropy that the Demon dumps represents degraded energy – energy drawn from the system by the process of observation and dissipation. In order for the system to 'keep cycling,' an equivalent amount of nondegraded energy must be returned to the Demon" (Leff and Rex 13-14). Oedipa must therefore "feed back something like the same quantity of information" to the Demon in the form of fresh energy to continue the Demon's successful sorting methods and consequently run the Nestafis Machine perpetually (Pynchon 84-85). An important note about the Nestafis Machine, then, is the fact that it is not an isolated system. Rather, it is an open system where entropy/energy can freely flow between the sensitive and the machine. Therefore, the second law of thermodynamics does not strictly pertain to the Nestafis Machine as it does Maxwell's Demon.

Still, Oedipa is unable to communicate with The Demon and decrease entropy; she is unable to provide external energy for the Demon. Grant states that "the importance of this association lies in its implicit recognition that Oedipa, like the Demon, needs to receive some form of energy from outside herself" (95). Oedipa needs external energy to break her isolated system of rising entropy. A fresh infusion of energy from the outside would create distinction, order, change. Many times, an outside force of energy seems as if it is about to break through, "as if, on some other frequency, or out of the eye of some whirlwind rotating too slow for [Oedipa's] heated skin even to feel the centrifugal coolness of, words were being spoken" (Pynchon 14). This energy source always alludes to but never arrives for Oedipa, however, as her system stays isolated and increases in entropy. These apparent revelations of fresh external energy often come in the form of seizures, a neurophysiological phenomenon. Because of this fact, we will be obliged to return to these concepts of revelations and external energy sources in much more detail when we turn our attention to the neuroscientific implications of *Lot 49*.

The rising entropy in *Lot 49* is well characterized through the media of communication utilized by its characters. As entropy increases towards heat death, communication continually ceases and corrupts itself in turn, a phenomenon with pernicious impacts on Oedipa. At the start of the novel, Oedipa is reading "book reviews in the latest *Scientific American,*"[22] which presents an intellectual exchange of information healthily occurring (Pynchon 2; Grant 13). As the novel marches onwards, however, distortion of information via communication channels increases as noise keeps getting added to the signal. Almost every conversation in which Oedipa participates results in some sort of miscommunication as the message the sender projects gets infected by noise before reaching the receiver. For instance, Oedipa remembers an event in which Pierce called her "at three or so one morning," exclaiming "'I've just come from Commissioner Weston, and that old man in the fun house was murdered by the same blowgun that killed Professor Quackenbrush' or something" (Pynchon 2-3). The information that Pierce communicates through the telephone to Oedipa becomes comically corrupted in transmission to the point where Oedipa, as receiver, cannot understand its content at all. Soon, this miscommunication hits a peak where it seems no one can understand anyone else. This reality is perhaps most explicitly stated when Mucho, reporting on Oedipa's Freudian psychotherapist Dr. Hilarius's mental breakdown at his clinic, announces "thank you, Mrs. Edna Mosh" into the radio show receiver after she provides her take on the situation, explaining to Oedipa that it will come out correct on the other end because of his allowance for inherent rig distortion (Pynchon 114). Grant claims that "Oedipa becomes a receiver, attempting to resolve the signals that emanate from her world into a discrete and organized message which will contain a meaning

[22] The November 1952 issue of *Scientific American*'s cover story featured the neuronal action potential (*Scientific American* volume 187, issue 5).

equivalent to the meaning of that world" (119).[23] Grant's explanation of Oedipa as a receiver attempting to sort information from noise as it gets corrupted in its signal from the transmitter is synonymous with Mangel's concerning Oedipa as Demon with gas molecules. Both state that the Tristero raises the entropy of Oedipa's quest as she simultaneously attempts to organize her information on them and their association. A small yet intriguing and significant explanation for the miscommunication noise exemplified in Mucho's "Mrs. Edna Mosh" is provided by literary critic Georgiana Colvile, who argues that "if you have to say Edna Mosh into the speaker to have it come out as Oedipa Maas, then a whole code may be involved which would displace the sound and meaning of *The Crying of Lot 49* in its entirety" (26). Whether or not you choose to believe Colville's argument, it lends credence to the fact that communication is sacred in its negentropic content in *Lot 49,* and, moreover, increasingly corrupted into noise by the perniciously entropic Tristero empire. Thus, the reader, like Oedipa, ultimately has no idea what is real and what is noise.

Going back now to the main point of Oedipa as Demon, it is obvious that Oedipa attempts to cybernetically decrease entropy through methods of feedback. Oedipa endeavors to use cybernetic feedback to discover, process, and react to information she gains about the Tristero to better organize this information in her head. This cybernetic feedback system, although it works on paper (and indeed also in some readings of *Lot 49* where Oedipa decreases in thermodynamic entropy as her day-to-day variation increases), does not quite work in practice. Oedipa does seem transiently to decrease entropy through her cybernetic sorting, but long-term this process only leads to more and more disorder. As we know by now, this consequence occurs because of Oedipa's perception. Oedipa, like the Demon, is beholden to her sense organs to

[23] This quotation was used in chapter one to help explain information entropy and its impacts on message content.

perform her sorting, and the environment needed by her sense organs to perform sorting naturally increases entropy in an isolated system. This rise in entropy most explicitly manifests itself in Oedipa's growing paranoia, the propagation of Tristero/WASTE signs, the increasing corruption and miscommunication of channels of information, and the rising blandness of Oedipa's surrounding landscape, among others. Oedipa needs an infusion of fresh energy from an external source to contest the ever-increasing levels of entropy in her isolated system, "another world's intrusion into this one" (Pynchon 97). This infusion of external energy teases Oedipa but never actually arrives to provide order, just as in what occurs with her as sensitive to the Nestafis Machine. This infusion of external energy cannot arrive because it cannot correctly communicate with Oedipa in the first place. Perhaps this miscommunication stems from the high levels of entropy in Oedipa's system or perhaps it stems from an alternate reason; the novel never elucidates the answer in either direction. Unlike in "Entropy," there is no apparent salvation for Oedipa, either; the reader is left in suspense as she enters the sealed courtroom to bid on the Tristero stamps.

Building on this conclusion and most importantly for the purposes of this thesis, Oedipa's cybernetic feedback methods have direct relations with the neuroscientific implications of *Lot 49*. The remainder of this thesis will show how mid-20th century neuroscience saturates every page of *Lot 49* to the point where an entirely novel and historically significant reading of the work can be gained. *The Crying of Lot 49* suddenly looks a lot different and (if possible) more interesting when one realizes the neuroscientific implications Pynchon is attempting to inject into his overarching postmodern commentary.

Chapter Six: Neuroscience in *The Crying of Lot 49*

The increase in thermodynamic and information entropy in *Lot 49* parallels, is manifested by, and manifests its neuroscientific implications. Accordingly, the mid-20th-century neuroscientific reflections in *Lot 49* not only incorporate the novel's entropic themes, but also its cybernetic, informatic, religious, philosophical, and other issues yet to be elucidated. As will be shown, the entire novel is an extended metaphor for the neuronal action potential and the cybernetic transfer of information it enacts in the nervous system. At the start of *Lot 49*, this operation is largely running smoothly as transfers of neuronal information succeed. As the novel progresses, however, disorder continues to rise as Oedipa futilely attempts to decrease her nervous system's entropy with alcohol. Eventually, Oedipa suffers malignant seizures because of her system's ever-increasing levels of entropy. Accordingly, the seizure "revelations" from another world attempting to break through to Oedipa can be read as an inherently mundane neuroscientific phenomenon, and therefore cannot hit Oedipa because of her already disordered nervous system. The neuron and nervous system's cybernetic transfers of information are thus an exact reflection of the entropy, information, and communication aspects occurring in *Lot 49*.

To show how Pynchon incorporates neuroscience into *Lot 49*, I will analyze two sweeping neuroscientific themes: alcohol and seizures. I will take one of these neuroscientific themes at a time, start from its first manifestation in the text, and then progressively expound on it as its significance grows throughout the novel. Once I have thoroughly elucidated what alcohol and seizures neuroscientifically mean in *Lot 49*, I will connect them through novel data analysis and discuss the extended neuroscientific metaphors reflected in the novel, like the action

potential. Through this method, I will also present how many solely neuroscientific phenomena[24] are inherent in *Lot 49*, both related to and independent of the cybernetic action potential. Afterwards, I will discuss the real-world neuroscientific philosophies, reflections, and opinions that are imbued in *Lot 49*. Thus, I will argue why *Lot 49* is a worthwhile read for anyone who wants to understand neuroscience and its cultural impacts better, especially mid-20th century neuroscience. Consequently, it will be presented that *The Crying of Lot 49* is so rife with neuroscientific concepts/phenomena that it can even be read as a book primarily concerned with neuroscience and its associated cultural, philosophical, historical, and scientific connotations.

Alcohol

Alcohol and its neurological effects are present throughout *The Crying of Lot 49*. The first sentence of the novel states that "one summer afternoon Mrs Oedipa Maas came home from a Tupperware party whose hostess had put perhaps too much kirsch in the fondue to find that she, Oedipa, had been named executor, or she supposed executrix, of the estate of one Pierce Inverarity" (Pynchon 1). Before Oedipa even realizes her sorting task at hand, she is already getting drunk on cherry brandy. Once Oedipa realizes the consequences of her role as executrix to Pierce's estate, she stands in the living room trying "to feel as drunk as possible. But this did not work" (Pynchon 1). Literary critic Molly Hite suggests that Oedipa attempts to feel drunk in a feeble effort to insulate herself against the implications of the task that now faces her; the fact that it does not work indicates that Oedipa is starting to rise "like Venus emerging from the sea… from a 'Californicated' level of existence into a new life" (73). The hypothesis that Oedipa is futilely attempting to insulate herself against the excess of information that now overwhelms

[24] "Neuroscientific phenomena" are defined as any phenomena that have neurological impacts and/or references to neuroscience. Neuroscientific phenomena therefore do not necessarily need to be a direct part of the "curriculum" of neuroscience, just implicate neuroscience in some way.

her, which fails because events are already too set in motion, is correct. There is another, neuroscientific, aspect of this introductory scene, however, that increases its meaning to the novel greatly.

As discussed concerning the short story "Entropy," alcohol decreases the information entropy of neurons by hyperpolarizing them. Alcohol potentiates the effects of the main inhibitory neurotransmitter GABA through enhancing the power of its binding to its associated receptors, which decreases the likelihood of neurons firing and thus sending information to each other. The less information, the less entropy. That Oedipa was already drinking and consequently feeling the effects of alcohol before she even gained knowledge of Pierce's estate suggests that she was already stuck in the beginnings of an isolated system where entropy is rising. The fact that Oedipa's attempt to feel drunk and thus decrease her information entropy does not work furthermore shows that the intensifying levels of entropy are already starting to become too much for her system to handle even at this inchoate stage. To compensate for this failure, Oedipa decides to drink whiskey with her husband, Mucho, when he arrives home from work (Pynchon 2-6). Throughout the rest of *Lot 49*, Oedipa will continue to get drunk in a futile attempt to lower entropy and procure meaning in her increasingly confusing world.

Pynchon's second chapter narrates the beginning of Oedipa's quest as executrix for Pierce's estate. The chapter's main action occurs when Oedipa meets Pierce's lawyer Metzger at the Echo Courts Motel, an establishment owned by the pseudo-British boy band "The Paranoids." Oedipa's encounter with Metzger at Echo Courts is inundated with alcohol. Metzger shows up at Oedipa's motel room with a "bottle of French Beaujolais," which Oedipa and Metzger begin to drink (Pynchon 17). Soon they are watching a movie on the hotel TV together, and Metzger pulls out a "bottle of tequila" from an inside coat pocket once they run out of wine

(Pynchon 21). Metzger was a child star in the movie, prompting Oedipa to bet him that the movie does not end on a happy note. They begin to play a game Metzger terms "Strip Botticelli," where for every question Oedipa asks about the movie to better elucidate the ending, she must take off an article of clothing (Pynchon 24). Oedipa consents to the game but immediately goes to the bathroom to put on as much of her clothing on as possible. The Paranoids then leave "a fifth of Jack Daniels" for Oedipa and Metzger, which Oedipa instantly drinks (Pynchon 28). Oedipa gets very drunk as "things grew less and less clear" for her (Pynchon 29). She eventually goes to the bathroom again and comes back to the motel room to find Metzger "fast asleep with a hardon and his head under the couch" (Pynchon 29). Oedipa runs on top of Metzger to wake him up and initiate sex, but first Metzger must spend "20 minutes, rolling, arranging her this way and that" stripping Oedipa, as she is too tired to do so herself (Pynchon 29). It takes so long that Oedipa falls asleep, finally waking up "to find herself getting laid" by Metzger until they climax together (Pynchon 29).

Literary critic J. Kerry Grant argues that "the gradual stripping away of the layers of insulation with which [Oedipa] has armored herself against Metzger suggests what is to come for Oedipa in the course of her investigations into the Tristero" (41). Oedipa's transition into the convoluted Tristero network exposes her to the underbelly of American society, a realm that she had no idea even existed while living her "past life" as a housewife with Mucho. Metzger stripping Oedipa of all her clothes until she is naked is synonymous with the Tristero stripping her of all the walls safeguarding her innocence. Eventually, Oedipa ends up naked to Metzger and to the seedy Tristero, torn free from her defense mechanisms and vulnerable to the true nature of a sinister America she has just recently discovered.

To perform this action in the first place, however, Oedipa must "insulate" herself as best as she can against the shocking and fear inducing Tristero with copious amounts of alcohol. Only when the information entropy of her mind and body are reduced with alcohol's depressive effects on the CNS can Oedipa confront the glaring truths of life that the Tristero provides. The Tristero overwhelms Oedipa with information entropy, obligating her to fight back in her own way with alcohol. This phenomenon is symbolized in Oedipa's sexual exploits with Metzger because only when she gets "dead" drunk can she be stripped of all her clothing and have sex with Metzger.[25] With alcohol's negentropic effects on information, Oedipa can bear the nefarious information entropy overload that the Tristero imposes and let them tear down her walls. As a significant side-note to this point, Oedipa was also experiencing an information overload with Metzger in her motel room. The information from the TV, Metzger's blathering, and the Strip Botticelli game rules engulf Oedipa to the point where she must drink herself under the table to endure their entropic effects on information. This situation with Metzger subsequently works as a metaphor for Oedipa's relations to alcohol and the Tristero's information entropy for the rest of the novel, in every chapter.

[25] Per literary critic Maurice Couturier's words: "[Oedipa] is not thinking about her husband any more, but trying to protect herself against sexual aggression. She is attracted to this actor/lawyer, but at the same time she is afraid of sex" (23). The Tristero stripping Oedipa of all her defensive walls scares her just as getting stripped by Metzger scares her, because of the horrifying truths and world reality she knows she will discover, maybe even about herself. However, I am not ignorant to how problematic this scene is in its suggestions. Couturier is a specialist on Vladimir Nabokov, and so looked at *Lot 49* primarily from the lens of *Lolita*. Pynchon, apparently being inspired by Nabokov while with him at Cornell, injected numerous references to *Lolita* in *Lot 49*. Echo Courts is a motel with "a representation in painted sheet metal of a nymph holding a white blossom" (Pynchon 16). "The face of the nymph was much like Oedipa's… she was smiling a lipsticked and public smile, not quite a hooker's but nowhere near that of any nymph pining away with love either" (Pynchon 16). Echo Courts as an establishment explicitly references Humbert Humbert in *Lolita*, who continually rapes 12-year-old Lolita, his perfect "nymphet," in numerous motels across the country. That Metzger is Humbert Humbert and Echo Courts one of his motels is even more explicitly referenced when Metzger runs away to get married to one of The Paranoids, Serge's, teenage girlfriend, who sadly sings "*What chance has a lonely surfer boy / For the love of a surfer chick, / With all these Humbert Humbert cats / Coming on so big and sick? / For me, my baby was a woman, / For him she's just another nymphet*" (Pynchon 120). That Metzger is raping Oedipa in this scene like Humbert Humbert rapes Lolita is a genuine comparison to make, and further casts pernicious shadows on the Tristero's informatic impacts on Oedipa.

In chapter three, Metzger orders bourbon, of which Oedipa partakes, at The Scope bar in San Narciso (Pynchon 34-36). In the days afterward, Oedipa and Metzger make "an enormous Thermos of tequila sours" and drive to Fangoso Lagoons, a property owned by Pierce, with The Paranoids (Pynchon 41). Soon afterward, Oedipa and Metzger watch *The Courier's Tragedy*, a play brimming with alcohol abuse (Pynchon 49-58). In chapter four, Oedipa pours herself "half a tumbler of Jack Daniels" while pursuing the "Trystero"[26] source in the *The Courier's Tragedy*, drinks "real homemade dandelion wine in small neat glasses" with Genghis Cohen, the philatelist hired to organize Pierce's stamp collection, and goes to The Scope multiple times (Pynchon 70-72; 75-76). In chapter five, Oedipa gets drunk with a mysterious man in a gay bar in San Francisco and then the next day drinks beer at a pizzeria in Kinneret with an LSD-rattled Mucho after attempting to visit Dr. Hilarius (Pynchon 89; 115). In chapter six, Oedipa drinks beer with Dr. Emory Bortz in an effort to obtain more knowledge about the history of the Tristero, downs Napa Valley muscatel for Driblette, the man who orchestrated the Tristero showing of *The Courier's Tragedy*, at his gravesite after his apparent suicide, and, finally, drinks "bourbon until the sun went down and it was as dark as it would ever get" at Echo Courts after learning about the Tristero bidder in the novel's concluding stamp auction (Pynchon 124; 132-133; 145). Oedipa is consistently and increasingly drunk throughout the novel as a way of insulating herself and coping with the influx of Tristero and/or Pierce information bombarding her senses and stripping her defensive walls, just as occurs during the Strip Botticelli game.

The menacing endpoint of Oedipa's imbibing is personified by the drunken old sailor whom she meets the morning after her nighttime San Francisco adventure, which was enacted as

[26] Although I use "Tristero" in this thesis, in *Lot 49* the organization's name randomly oscillates between "Trystero" and "Tristero," a reflection of the organization's ambiguousness and high information entropy. There will never be one set definition for any facet of the Tristero, as noise associates with all their activities.

a hopeless attempt to get her mind off the Tristero. After wandering the city all night in her "linearly fading drunkenness," Oedipa exits a jitney in the morning with her "mouth tasting of old booze" (Pynchon 95; 101). Oedipa walks towards the San Francisco waterfront and soon happens upon "an old man huddled, shaking with grief she couldn't hear" in an open doorway (Pynchon 101). He has the muted post horn symbol tattooed on his left hand, which piques Oedipa's curiosity. Oedipa approaches the old man, and he gives her a letter to send to his long-lost wife via W.A.S.T.E. post. Overcome by the sadness of the old man's situation, Oedipa holds him in her arms while he cries. The old man's friend, Ramirez, then appears at the top of the staircase, and it soon emerges that the old man was a sailor. Oedipa helps Ramirez get the sailor to their room and offers him $11, to which he replies, "I'll spend it on booze" (Pynchon 104). Oedipa realizes, "because she had held [the sailor], that he suffered from DT's. Behind the initials was a metaphor, a delirium tremens, a trembling unfurrowing of the mind's plowshare" (Pynchon 104). Oedipa furthermore ponders how "so much could be lost, even the quantity of hallucination belonging just to the sailor that the world would bear no further trace of" (Pynchon 104). Oedipa understands that there is nothing she can do for the sailor besides mail his letter via W.A.S.T.E., and thus bids him goodbye and "walks in the direction he told her" (Pynchon 105).

Most scholarship on this key scene has focused on its connections to John Nestafis and his Maxwell's Demon machine. Nestafis's talking point concerning "one little movement, against all that massive complex of information, destroyed over and over with each power stroke" parallels what will happen when the old sailor dies (Pynchon 85). All the hallucinations and thoughts pertaining to the sailor will be lost forever in a massive destruction of information that is just like what occurs when the Demon in the Nestafis Machine must clear its mind's memory to continue sorting. This destruction of information causes environmental entropy to

rise, which cannot be reversed; as interdisciplinary scholar N. Katherine Hayles states when considering the sailor's death, "the total mass and energy may remain constant, but the delicate webs that connect neurons to thoughts, electrons to memory and feeling, are gone forever" (115).[27] When the sailor dies, it is impossible to reconstruct his memories. Oedipa realizes this fact with the sailor and becomes overwhelmed by its implications. She understands the significance and importance of the thoughts, memories, feelings, information, of even the most "wasted" outcasts of society and grasps how much of their intimate information is irreversibly destroyed every day. Oedipa, amid her overwhelming emotions concerning these facts, embraces the old sailor out of pity. Feminist critic Annette Kolodny and novelist Daniel Peters claim that this embrace "is a recognition on [Oedipa's] part of the value of the possibilities that might be contained in [the sailor's] warped visions of the world" (82). Oedipa apprehends that there is little she can do for the sailor but express empathy through her embrace and mail his letter. The sailor's words have worth and should not burn out in a destruction of information like the rest of him; Oedipa mails the letter to make sure the sailor's information gets transmitted. Her action shows her conviction that the sailor has value, even if American society does not think so.

In presenting the neuroscientific side to this scene, it is useful to first consider an allusion it makes to *V.*, the first novel Pynchon wrote. The sailor in *Lot 49* has visions no one else has ever had, "if only because there was that high magic to low puns, because DT's must give access to dt's of spectra beyond the known sun, music made purely of Antarctic loneliness and fright" (Pynchon 105). In *V.*, a drunk by the name of Hugh Godolphin, whose main scene revolves around his attempt to steal Botticelli's *The Birth of Venus*, coincidentally suffers from a delirium

[27] Hayles does not discuss neuroscience in her essay; the fact that she still chooses to talk on neurons and their networks in this scene shows how implicated neuroscience is in the significance of *Lot 49*, even if it is not consciously realized by scholars.

tremens episode quite similar to that of the old sailor in *Lot 49*: "In the polar wasteland of his delirium tremens, the old drunk has had a vision of the ultimate alienation, of the static and dehumanized Kingdom of Death" (Pynchon, *V.* 96). Both cases of delirium tremens reference the polar regions and their relations to isolation, loneliness, fright, and death. Antarctica is the largest desert in the world, and the Arctic is the second largest (Friedmann 1045; Woodford 6-7). Deserts are synonymous with areas of stillness, lifelessness, and sameness. The polar regions of Hugh Godolphin's and the sailor's delirium tremens hallucinations thus insinuate an unchanging sameness, a wasteland where there is little to no life. In other words, their delirium tremens hallucinations bring visions of entropic heat death, where everything is the same – "static" – and always will be. That Hugh Godolphin's and the sailor's delirium tremens episodes manifest horrifying visions of worlds corrupted with overwhelming entropy is certainly confusing at first, but makes perfect sense when the neuroscientific aspects of delirium tremens are brought in.

Delirium tremens (DTs) is an ailment that is caused by alcohol withdrawal after a previous period of heavy abuse. Delirium tremens usually lasts 2-3 days and causes confusion, tremors, heart palpitations, sweating, high blood pressure, paranoia, fever, and, sometimes, seizures and hallucinations (Schuckit 2109-2110; Healy 293). As we know, alcohol provides its depressing effects by increasing the inhibitory effects of GABA. Alcohol also inhibits the primary excitatory neurotransmitter, glutamate, through similar effects on glutamate's associated receptors. Consequently, neuronal excitability is decreased as neurons fire and communicate less. The more an individual drinks, the more these inhibitory effects manifest themselves. When a severe alcoholic withdrawals from alcohol, "there is an abrupt cessation of the neuronal inhibition and a subsequent state of hyperexcitability" ("Delirium tremens"). This hyperexcitability causes the neurons to fire too much, resulting in a possible seizure. This

overloading of seizure information can cause auras, hallucinations, visions, etc. (Vignal et al. 88). In the past, seizures were often associated with hallucinations of the holy sort where the afflicted individual was imparted with divine information during their attack (Ali et al. 685). Seizures were believed to communicate revelations through their hallucinations. The prophet Mohammed's utterances have even been linked by some to epileptic seizures (Freemon 423). Delirium tremens can thus cause hallucinations on two fronts simultaneously; from its base alcoholic withdrawal symptoms and its seizure symptoms, which are connected yet separate in their manifestations.

Although it is not clear whether the sailor is suffering a hallucinatory seizure when Oedipa meets him, he almost certainly has in the past. The fact that the sailor's "DT's must give access to dt's of spectra beyond the known sun" that consequently instill "Antarctic loneliness and fright" heavily insinuates a seizure (Pynchon 105). Spectra is plural for spectrum, which is "an image or distribution of components of sound, particles, etc., arranged according to such characteristics as frequency, charge, and energy" (Oxford English Dictionary). Spectra are usually synonymous with the range of different wavelengths or *frequencies*. As will be discussed in the following section on seizure, a significant aspect of epilepsy is the frequency changes in neuronal oscillatory activity that it causes in seizure impacted neural tissue (Jacobs et al. 1893). Moreover, when Oedipa suffers her first real revelatory seizure, it too is explained in the form of words "on some other frequency" (Pynchon 14). The fact that the sailor's delirium tremens gives access to different frequencies suggests that it gives access to the different frequencies inherent in a seizure. The resulting seizures from delirium tremens propagating the hallucinations rather than the delirium tremens itself would also make more sense. Seizures create an information entropy heat death in the brain through their excess of neuronal firing, which is reflected in the

sailor's hallucinations through an inert heat death vision. Hence, the sailor is suffering thermodynamic heat death hallucinations because of the information heat death of his brain by seizure, seizures that resulted from his delirium tremens.

As Oedipa continually attempts to minimize her system's information entropy through drinking, she increasingly risks an eventual information entropy heat death. Seizures will befall her from delirium tremens withdrawal symptoms just as they did with the sailor, and her mind will be overloaded with uncertainty, noise, and entropy. A decrease of information entropy fueled by alcohol will in the long run only provide Oedipa with an entropic maximum in which revelatory communication is not possible, only striking in the form of nightmare seizure heat deaths. Accordingly, the seizures that befall Oedipa throughout *Lot 49* are false revelations of negentropic energy, and instead perform the exact opposite function of *raising* her system's entropy. These epileptic events often coincide with Oedipa's drinking, further presenting the intimate link between the two neuroscientific phenomena. We will now investigate this possibility more with an exploration of Oedipa's frequent seizures.

Seizures and the Word

The potential communication of revelatory information through seizures is a vital part of *Lot 49*. Because pure information and energy are virtually synonymous, this imparting of information from the "outside" would revitalize Oedipa's system and stave off the impending prospect of heat death. Whenever Oedipa suffers a seizure, it seems that the revelatory information from outside is about to break through to refresh her isolated system, yet it never arrives.[28]

[28] Pynchon critics Edward Mendelson and C. E. Nicholson, among others, have written liberally on Oedipa's seizures in the context of religion. These critics equate the influx of new energy into Oedipa's isolated system to be

The notion of an outside energy source intruding into the isolated system that is *Lot 49*'s world centers around Jesus Arrabal. Oedipa meets Arrabal during her San Francisco meandering. Oedipa enters "an all-night Mexican greasy spoon off 24th" to find "a piece of her past, in the form of one Jesus Arrabal" (Pynchon 96).[29] Oedipa met Arrabal in Mazatlán, on a vacation with Pierce. Arrabal is in exile because his anarchist group failed in its mission. Arrabal now co-owns the Mexican restaurant Oedipa enters along with another revolutionary, both still waiting for the day their anarchist revolution will come. On the topic of his revolution, Arrabal states:

> You know what a miracle is. Not what Bakunin said. But another world's intrusion into this one.[30] Most of the time we coexist peacefully, but when we do touch there's cataclysm. Like the church we hate, anarchists also believe in another world. Where revolutions break out spontaneous and leaderless, and the soul's talent for consensus allows the masses to work together without effort, automatic as the body itself. (Pynchon 97)

On this topic, Grant states that "politics and thermodynamics come together in Jesus's theory of miracles. The intrusion from outside of some form of knowledge – elsewhere referred to as revelation, the Word – constitutes the necessary infusion of new energy into a potentially closed system" (103). If another world intruded into Oedipa's, it would provide an infusion of new energy to invigorate her system. Oedipa furthermore believes that this information energy is sacred, alike to God's Word. As discussed previously, seizures have a past reputation for being

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sacred. This thesis is the first work to discuss Oedipa's seizures from a primarily thermodynamic/scientific standpoint.

[29] Arrabal is probably a part of the Tristero. "an ancient rolled copy of the anarcho-syndicalist paper *Regeneracion*" was present at Arrabal's restaurant with a "handstruck image of the post horn" on it (Pynchon 98). Arrabal as a member of the Tristero has much significance for Oedipa's quest and seizures, as will be further elucidated in the rest of this section.

[30] This quotation was also utilized in the previous chapter on *Lot 49* scholarship to explain why Oedipa's world continues to increase in entropy.

sacred. This reputation, however, is false; seizures are not viable media to impart sacred information because seizures are purely neuroscientific and thus corporeal in their existence. Even as early as Ancient Greece, Hippocrates argued "against the belief widely held at the time that epilepsy's cause is spiritual. On the contrary, Hippocrates found epilepsy's etiology to be just like that of any other disease: grounded in physiologic principles" (Ali et al. 685). However, perhaps in part because of Arrabal, Oedipa continues to believe seizures are a form of Godly salvation against the Tristero that imbue negentropy into her system, when, in reality, they are the exact opposite; Oedipa's seizures are mundane high-entropy attacks propagated *by* the Tristero.

Oedipa suffers numerous seizures throughout *Lot 49*, all associated with a vague promise of revelation for her. The first major seizure befalls Oedipa when she is driving on the vein of a road that connects Kinneret to San Narciso, to meet Pierce's lawyer, Metzger. As Oedipa first enters San Narciso, she looks out at the housing complexes:

> …so in her first minute of San Narciso, a revelation also trembled just past the threshold of [Oedipa's] understanding. Smog hung all round the horizon, the sun on the bright beige countryside was painful; she and the Chevy seemed parked at the centre of an odd, religious instant. As if, on some other frequency, or out of the eye of some whirlwind rotating too slow for her heated skin even to feel the centrifugal coolness of, words were being spoken.[31] She suspected that much (Pynchon 14)

Although it is not directly stated, it is obvious that the revelation trembling just past the threshold of Oedipa's understanding is being channeled through the medium of a seizure. Grant argues that

[31] Quotation from the previous chapter on *Lot 49* to explain the outside forces of energy that constantly elude Oedipa.

"this moment is potentially religious in part because of Oedipa's sense that the message she is not quite able to receive is being transmitted from somewhere beyond the confines of normal experience" (30). It is being transmitted from some other frequency, but not a sacred frequency.

A potential biomarker of seizures is high-frequency oscillations, which are repetitive patterns of neuronal network ensembles firing abnormally fast ("High Frequency Oscillations"). High-frequency oscillations are most likely linked to epileptogenesis in humans. High-frequency oscillations are often associated with regions of the epileptic brain that foundationally and indispensably help generate seizures, called epileptogenic zones or foci (Jacobs et al. 1893; Jacobs et al. 302). Resecting areas of brain tissue that display high-frequency oscillations often results in much better postsurgical seizure outcomes than resecting areas of brain tissue that do not (like traditional seizure-onset zones), further indicating that high-frequency oscillations mark areas of the brain critically associated with seizure generation (Zijlmans et al. 169).[32] Therefore, a revelation coming to Oedipa from "some other frequency" directly connects to the phenomenon of seizures generating abnormal frequencies in impacted neural tissue. A revelation may be attempting to intrude into Oedipa's world, but it is through the abnormal frequency of a seizure, not another (possibly sacred) world. That Oedipa experiences her first real seizure when entering San Narciso further makes sense when considering that it is where she first meets the Tristero.

Revelations tremble past Oedipa's *threshold* of understanding when she enters San Narciso. A seizure threshold defines the line that must be crossed to generate a seizure.

[32] I have determined these definitions of "epileptogenic zones" and "seizure-onset zones" from Rosenow and Lüders' liberally cited 2001 paper "Presurgical evaluation of epilepsy," wherein they define seizure-onset zones as "the area of the cortex from which clinical seizures are (actually) generated" and epileptogenic zones as "the area of cortex that is indispensable for the generation of epileptic seizures" (1684; 1686).

Epileptics have lower seizure thresholds than normal, meaning that it takes less excitatory neuronal activity to generate a seizure ("Seizure Threshold"). It is worth noting that alcohol increases seizure threshold while the individual is intoxicated but decreases the seizure threshold afterwards, a main effect in delirium tremens (Hilbom 1013). The fact that Oedipa's revelation trembles on the threshold of her understanding perhaps suggests that the seizure does not occur, but almost does. However, as Oedipa drinks throughout *The Crying of Lot 49*, her seizure threshold continues to fall as the potential for seizures increases. Thus, Oedipa suffers an unknown multitude of seizures as the novel progresses.

The sinister potential of seizures and their associated "revelations" hammer Oedipa as she enacts her Tristero quest. When Oedipa is watching TV with Metzger,[33] a commercial for one of Pierce's housing projects flashes on screen. Oedipa and Metzger are already both profusely drinking. The commercial reminds Oedipa "of her look downhill this noontime. Some immediacy was there again, some promise of hierophany:[34] printed circuit, gently curving streets, private access to the water, Book of the dead…." (Pynchon 20). The promise of sacred revelatory information is suggested through the TV screen by linking itself to the experience Oedipa just had on the road when entering San Narciso. Networks of roads, lines, and blood vessels will continue to possess sacred meaning for Oedipa throughout *Lot 49* because of their suggestions toward the neural networks supporting her seizures. Moreover, the promise of a seizure revelation that hints at breaking through but may not have makes sense here when considering that Oedipa was drunk when viewing the commercial. As stated above, alcohol

[33] David Seed argues that "one of Metzger's main roles in the novel is to alert Oedipa to Inveriarty as a force" (118). Metzger invokes Pierce to Oedipa, which implicates his relations to the Tristero as a result. Thus, the Tristero and their high information entropy impacts are again present during Oedipa's seizure, as they always are.
[34] "Hierophany" probably references religious historian Mircea Eliade's use of the word to mean "the *act of manifestation* of the sacred" from the "profane" world usually inhabited (quoted in Mendelson 122). That Oedipa ties hierophany to her revelations further exemplifies that they feel sacred to her in their content.

increases seizure threshold when one is intoxicated. Therefore, Oedipa's seizure has a harder time compromising her system and is less powerful than it would if Oedipa were not drunk.

On a more minute scale, Oedipa could be having seizures when she first meets Driblette backstage after seeing *The Courier's Tragedy*. She stares into Driblette's eyes, which are "bright black, surrounded by an incredible network of lines, like a laboratory maze for studying intelligence in tears. They seemed to know what she wanted, even if she didn't" (Pynchon 60).[35] These eyes cause something to come "to [Oedipa's] viscera" briefly as Driblette suggests Oedipa attempt to find a copy of *The Courier's Tragedy* at Zapf's Used Books (Pynchon 61). Just before Oedipa encounters Driblette's network of eye lines, she "walked in on soft, elegant chaos, an impression of emanations, mutually interfering, from the stub-antennas of everybody's exposed nerve endings" in her attempt to find Driblette in the dressing room (Pynchon 60). This description of the dressing room instantly evokes a scene of high neuroscientific information entropy. In the dressing room, everybody's efferent nerves – neuronal axons that send information from the central nervous system out to the body's periphery, usually to act on muscles or glands – are sending information out into the world, acting like antennae transmitting electromagnetic waves ("Efferent Nerve"). These nerve projections are interfering with each other, increasing the room's noise and thus information entropy. When considering that this is the environment where Oedipa meets Driblette, who is probably a member of the Tristero,[36] it

[35] "Once again Oedipa confronts a potential source of enlightenment in the form of a grid or network that 'seems' to be capable of communicating knowledge. Like the streets of San Narciso and the map of Fangoso Lagoons, Driblette's eyes urge Oedipa toward revelation" (Grant 63). Once again, a network procures revelation in Oedipa because of its insinuations toward "divine" epilepsy.

[36] I am judging this position on the fact that Driblette has the lines "*No hallowed skein of stars can ward, I trow, / Who's once been set his tryst with Trystero"* (Pynchon 58). Which, according to Dr. Bortz, should only appear in a vulgar copy of *The Courier's Tragedy* that is in the "Vatican library" (Pynchon 124). Per interdisciplinary scholar John Johnston's words: "[perhaps] Driblette has been asked by someone, for unknown reasons, to pronounce these particular lines for this performance" (63). That is, the performance of *The Courier's Tragedy* that Oedipa watches.

makes sense that the network of lines in his eyes would cause a seizure "revelation" to occur in Oedipa's viscera; the information entropy was already high enough in the room to kindle one.

While Oedipa is drinking dandelion wine with Genghis Cohen, she experiences her most explicit seizure in the novel. Cohen tells Oedipa how the dandelions he used to make the wine came from a cemetery now torn up to make way for the freeway, when Oedipa has an attack:

> [Oedipa] could, at this stage of things, recognize signals like that, as the epileptic is said to – an odor, color, pure piercing grace note announcing his seizure. Afterward it is only this signal, really dross, this secular announcement, and never what is revealed during the attack, that he remembers… it came to her that she would never know how many times such a seizure may already have visited, or how to grasp it should it visit again. Perhaps even in this last second – but there was no way to tell. (Pynchon 76)

Cohen[37] then shows Oedipa a W.A.S.T.E. marked postage stamp, prompting Oedipa to wonder "how much time had gone by," with the implication being that "Oedipa has once again experienced a kind of seizure, an absence, that has been heralded by the appearance of the WASTE symbol" and the high information entropy that it brings along with its numerous manifestations (Pynchon 77; Grant 77). Pynchon hints here that Oedipa has had numerous past seizures, most escaping her consciousness, and that she will continue to suffer them in the future. As the Tristero's information entropy ramps up and Oedipa continues to drink, her nervous system suffers lower seizure thresholds and is more prone to information overloads turning into seizures. Thus, Oedipa will continue to have seizures because of the intense information entropy

[37] Literary critic John W. Hunt, among others, believe that Cohen is a member of the Tristero based on how thoroughly associated with W.A.S.T.E. and the Tristero he is (38). Cohen being a member of the Tristero would make sense in that it would lend further credence to Oedipa's seizure with him.

that the Tristero imparts to her brain, most not being illuminated to the reader because Oedipa herself does not know or understand when they strike.

Oedipa's realization that "she would never know how many times such a seizure may already have visited," and then subsequent wonder about "how much time had gone by" when Cohen shows her the W.A.S.T.E. stamp, calls back to Oedipa's recent past at Yoyodyne. Right before Oedipa meets Stanley Koteks, she is on a tour of the Yoyodyne factory with its stockholders. However, "somehow Oedipa got lost.[38] One minute she was gazing at a mockup of a space capsule, safely surrounded by old, somnolent men; the next alone in a great, fluorescent murmur of office activity" (Pynchon 66). Oedipa suffers a seizure in the form of a lapse of consciousness, just like what occurs with Genghis Cohen. Her seizure causes her to be separated from her tour group and to encounter Stanley Koteks, a member of the W.A.S.T.E. network and thus Tristero. Therefore, Oedipa's Yoyodyne seizure, a high entropy attack that makes her lose consciousness, leads her to the Tristero, an organization of high entropy. Once again, seizures and the Tristero are connected in their high levels of information entropy. Perhaps if Oedipa did not have her seizure, she would never run into the Tristero again, eventually forgetting about them and eluding the heat death fate that so threatens her.

When Oedipa starts her nighttime San Francisco adventure through "its far blood's branchings, be they capillaries too small for more than peering into, or vessels mashed together in shameless municipal hickeys, out on the skin for all but tourists to see," she laments losing her

[38] When Oedipa suffers a seizure with Cohen and realizes that "she would never know how many times such a seizure may already have visited," she sees, "for the very first time, how far it might be possible to get *lost* in this" (Pynchon 76) (My Italics). Seizures, propagated by the Tristero, cause Oedipa to become lost and confused because of their high amounts of information entropy.

revelatory seizures (Pynchon 95).[39] Concerning the proliferation of W.A.S.T.E. symbols around San Francisco, Oedipa wonders if they are only some kind of compensation "to make up for her having lost the direct epileptic Word, the cry that might abolish the night" (Pynchon 95). "The night" stands for Oedipa's entrapment in the network of Tristero, her visceral unease about not fully understanding the conspiracy unfolding around her. Oedipa desires an epileptic seizure to break through into her system, refresh it with energy, and give her the insight she needs. Oedipa still does not understand the perniciousness of seizures, and never will. The direct, epileptic, Word will not abolish the night as Oedipa so believes; instead, it will *darken* the night, being propagated by the Tristero's high information entropy tendencies. Literary critic Tony Tanner notes that "the 'cry' that might have ended the night is replaced by a 'crying' that can only extend it" (181). Oedipa believes that her seizures are a negentropic "cry," but in reality, they are an entropic "crying." Hence, *The Crying of Lot 49*.

The second and most important reference to revelation/the Word after Oedipa's realization with Cohen is prefaced by the word in its secular meaning, regarding language. Oedipa, at this point, is still anxiously awaiting the arrival of another seizure. When Oedipa drinks beer with Dr. Emory Bortz and his graduate students to discuss *The Courier's Tragedy,* Bortz tells Oedipa that Driblette "felt hardly any responsibility to the word, really; but to the invisible field surrounding the play, its spirit, he was always intensely faithful" after a graduate student divulges that Driblette has just (presumably) committed suicide (Pynchon 125).[40] Instead

[39] It is likely that Oedipa believes she "loses" her revelatory seizures because alcohol intoxication makes them harder to occur. Oedipa has been drunk increasingly often before this point in San Francisco and has subsequently likely felt numerous seizures *about* to or *almost* hit but ultimately halted before full attack because of her comparatively high seizure threshold during intoxication.

[40] Once Oedipa hears that "Randy [Driblette] walked into the Pacific two nights ago," she keeps "a silence, waiting, as if to be illuminated" (Pynchon 125). Oedipa is waiting for a "revelatory" seizure to hit her, still having faith in their sacred negentropic abilities even this late into her quest. That it does not come unnerves her, even though she is obviously better off without one. The absence of a seizure suggests that Dr. Bortz is not a member of the Tristero.

of being concerned with a work's text, Driblette was concerned with its spirit, with how it made him feel on any given day. Driblette does claim, after all, that he is "the projector at the planetarium, all the closed little universe visible in the circle of that stage is coming out of my mouth, eyes, sometimes other orifices also," a direct reference to an isolated system where entropy must naturally rise (Pynchon 61). That Oedipa innately follows this advice, copying in her memo book "*shall I project a world?*" and pondering how to "if not project then at least flash some arrow on the dome to skitter among constellations" shows just how prone Oedipa is to entering an entropic system (Pynchon 64-65). Literary scholar Edward Mendelson argues that Driblette suffers from a "nihilistic pride that thinks itself the only possible source of order in the universe" (125). Consequently, to Mendelson, "the logical response to a world where one creates, alone, the only order – where one ignores the *data* of the word – is nihilistic despair" (125). Driblette's playwright style is solipsistic, caring only for his world. Solipsism in *Lot 49* is synonymous with a retreat into one's own mind, into an isolated system where entropy must rise until heat death. The fact that Driblette chooses to commit suicide because of his solipsistic heat death is "the logical culmination of an exclusive devotion to the spirit," which Driblette presents in his plays, a narcissistic final hurrah onto the great beyond (Mendelson 125). Thus, even when going to death Driblette maintains a heat death: an ideal that is soon pertinent to Oedipa.

Soon after learning of Driblette's death, Oedipa drinks Napa Valley muscatel at Driblette's gravesite in mourning. Oedipa wonders if "perhaps her mind would go on flexing psychic muscles that no longer existed" and attempts "to reach out, to whatever coded tenacity of protein might improbably have held on six feet below, still resisting decay" (Pynchon 133). Oedipa desires "a transient, winged shape" of Driblette to "settle at once in the warm host" of her body (Pynchon 133). Soon, Oedipa feels "briefly penetrated, as if the bright winged thing had

actually made it to the sanctuary of her heart" (Pynchon 134). Oedipa's longed-for seizure finally arrives. Oedipa waits "for the winged brightness to announce its safe arrival. But there was silence. Driblette, she called. The signal echoing down twisted miles of brain circuitry, Driblette!" (Pynchon 134). Defeated, Oedipa finally admits that "as with Maxwell's Demon, so now. Either she could not communicate, or he did not exist" (Pynchon 134).

Grant argues that the transient, winged shape is "another of the novel's annunciatory images… [Driblette's spirit] may be the revelation that will energize [Oedipa] once more" (128). This annunciatory image comes in the context of a seizure, as all revelations do in this novel. Oedipa attempts to drink muscatel to decrease her information entropy to communicate with Driblette. It seems as if the alcoholic attempt works, as Oedipa feels her revelatory seizure coming on and information from Driblette making its way into her mind. The seizure's revelation soon vanishes, however, as it leaves no real message. Oedipa, in despair, tries to communicate with Driblette down "twisted miles of brain circuitry" to no avail.

The revelation from Driblette does not come to Oedipa for a multitude of reasons. For one, seizures increase information entropy and therefore are inconducive to imparting information through messages. Moreover, as touched on previously, alcohol increases seizure threshold while one is intoxicated. Secondly, Driblette was always against information "the word" could impart, choosing to stick to his own imagination instead. Thus, it would be silly to believe that a spectral Driblette would suddenly decide to utilize "the word" as a medium of communication. Thirdly, Driblette walked into the ocean while in the state of an entropic heat death. Therefore, a plea down miles of brain circuitry, as Oedipa is performing with Driblette, is worthless; the seizure was only an attempted attack by the Tristero (of which Driblette was most likely a member), not a revelation. The Tristero is still one step ahead of Oedipa and thoroughly

duping her as she pleads for a revelation from a man who is a part of the organization making her life miserable with those very same "revelations" of seizure entropy.

Unsurprisingly, then, Oedipa almost completely cracks at the end of her Tristero quest. When Oedipa learns from Cohen that the Tristero itself may be attempting to bid on Pierce's lot of counterfeit W.A.S.T.E. stamps, she drinks "bourbon until the sun went down and it was as dark as it would ever get" and then drives "on the freeway for a while with her lights out, to see what would happen" (Pynchon 146). Oedipa eventually exits her car to talk on a pay phone with the mysterious man she met at the San Francisco gay bar, and he too ignores her and refuses to imbue her with any negentropic information. "Her isolation complete," Oedipa walks down a stretch of railroad track in the night (Pynchon 146). Oedipa then has an internal monologue:

> Might Oedipa Maas yet be [Pierce's] heiress; had that been in the will, in code, without Pierce really knowing, having been by then too seized by some headlong expansion of himself, some visit, some lucid instruction? (Pynchon 147)

Oedipa gets drunk on bourbon and then speaks on Pierce and seizures, a link of the two neuroscientific phenomena at the ending and most significant part of *Lot 49*. Grant argues that:

> Oedipa lists three possible causes for Pierce's lack of awareness of what is encrypted in his will: 'some headlong expansion of himself, some visit, some lucid instruction.' The serial nature of the syntax allows for the possibility that Oedipa is describing a sequence of 'events' that have taken place as a form of seizure. In this formulation, the will becomes 'the secular announcement,' the 'compiled memories of clues, announcements, intimations' that is all that remains after seizure, and not 'the central truth itself' that is

> here represented by the 'lucid instruction' that is communicated to Pierce as a form of revelation, 'a visit.' (135-136)

In this sense, Pierce too suffered from at least one seizure. Pierce's seizure does not impart any central truth to himself because of the influx of information entropy represented by a seizure network. Therefore, all that is left is "the secular announcement" of the will, which leaves no certain information. As a result of the informationally high seizure, the will instead serves only to *increase* entropy. The will reflects the seizure's high information uncertainty by leading Oedipa on the Tristero quest and their information heat death. A seizure, most likely propagated by the Tristero on to Pierce, was thus the catalyst to Oedipa's own nightmare Tristero quest.

In the page below, I have categorized every main scene in *The Crying of Lot 49* and have created multiple tables and graphs around the presence of alcohol and/or seizures in them. Table one displays whether alcohol and seizures are present in what I deem to be the 16 most important scenes of *Lot 49*. Green means that alcohol/seizures are present in said scene; red means that alcohol/seizures are not. Table two shows that out of 16 key scenes, 2 do *not* have alcohol and seizures; 8 have alcohol *or* seizures; and 6 have alcohol *and* seizures together. Graph one is a pie chart that elaborates from table two, explaining that of the 16 key scenes, 12.50% have neither alcohol or seizures, 37.50% have alcohol *or* seizures, and 50% have alcohol *and* seizures.

Table One

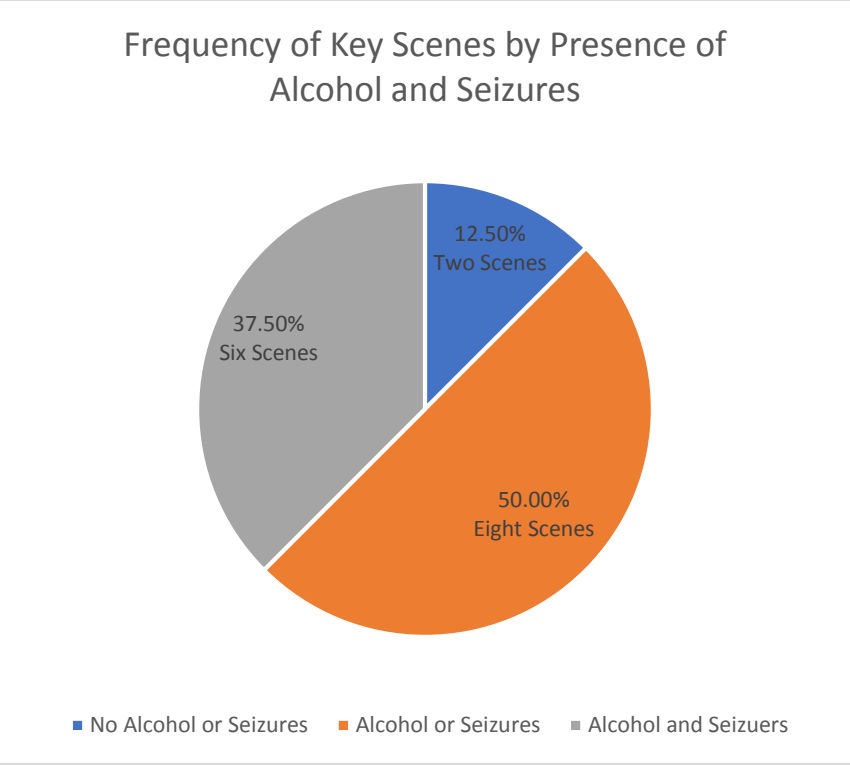
Present
Absent

Scene	Alcohol	Seizures
Oedipa and Mucho's Kinneret House		
Oedipa Visits the Remedios Varo Painting in Mexico		
Oedipa and Metzger Meet at Echo Courts		
Oedipa and Metzger go to The Scope		
Oedipa, Metzger, and The Paranoids Travel to Fangoso		
The Courier's Tragedy		
Oedipa Visits Yoyodyne		
Genghis Shows Oedipa the First Tristero Stamp		
Oedipa Visits John Nestafis		
Oedipa in San Francisco		
Oedipa and the Old Sailor		
Oedipa Confronts Dr. Hilarius		
Oedipa Sees Mucho on LSD		
Oedipa Visits Dr. Bortz		
Oedipa Visits Driblette's Grave		
Oedipa's Final Days Before the Stamp Auction		

Table Two

Key Scenes without Alcohol and Seizures	2
Key Scenes with Alcohol or Seizures	8
Key Scenes with Alcohol and Seizures	6

Graph One



I have attempted to be as conservative as possible when calculating these statistics, to avoid arguing for anything not specifically mentioned in the text. Even with my conservatism, however, the prodigious proliferation of neuroscience through the lens of alcohol and seizures leaps off the page. Out of 16 key scenes, alcohol or seizure appear in 14 (87.50%) throughout *Lot 49*.[41] Moreover, drinking and epilepsy are unmistakably connected to each other, as presented by the number of scenes in which they appear together. Seizures and alcohol neurologically hound Oedipa as she submits to the entropic impacts of the Tristero. Neuroscience is thus an essential aspect of *The Crying of Lot 49*.

A few widespread arguments in *Lot 49* scholarship concern whether the Tristero are malevolent, whether any revelatory communication occurs, and, finally, whether entropy rises or not. The neuroscience of *Lot 49* offers an answer to each of these questions. The Tristero, unequivocally, are an ill force for Oedipa. They ramp up information entropy to the point that Oedipa has seizures of thermodynamic and informatic entropy that she cannot control, and that prevent any information flow. Furthermore, the Tristero cause Oedipa to become an alcoholic in an attempt to combat their entropic forces. The irony of Oedipa's alcoholic situation is displayed in the fact that she drinks alcohol to decrease her nervous system's entropy against the Tristero, yet still believes in the miraculous nature of her seizures; seizures propagated by the Tristero. Oedipa drinks alcohol as a means of communicating with these seizure revelations, which, much to her chagrin, cannot as easily occur while she is intoxicated because of her heightened seizure threshold. However, also because of her alcohol abuse, these seizures *do* frequently visit her

[41] I will explain in the concluding chapter the seizure that occurs to Oedipa when she visits John Nestafis, as it cogently summarizes *The Crying of Lot 49* in neuroscientific terms.

when she is not drunk, because of her subsequently *decreased* seizure threshold.[42] Oedipa, of course, is happy about this situation, because she believes these seizure revelations are negentropic energy that will fight the Tristero by imbuing her with some sort of divine insight. Oedipa has no idea that these seizures are instead products of the Tristero and only impart information entropy heat deaths. Oedipa is falling right into the Tristero's net and marching along towards higher and higher levels of entropy with her drinking and seizures until heat death.

Although the true motives of The Tristero are unclear throughout *Lot 49*, I suggest that The Tristero are purposely torturing Oedipa with information entropy. Pierce eventually dies, most likely because his seizures amounted to an inescapable heat death,[43] leaving only his will, a product of these seizures. That Oedipa's name is written on the will means that she was *meant* to be implicated in the Tristero's organization. Oedipa was *meant* to undergo her Tristero quest and suffer the same seizures that Pierce once did. The fact that Oedipa seems to have done nothing in her past to enrage the Tristero is confusing when one considers just how malicious the organization is being to Oedipa. However, I argue that the Tristero are angered at Oedipa through Pierce. Pierce, as a millionaire "real estate mogul," stands for everything the Tristero is against (Pynchon 1). Pierce must have wrongly crossed the Tristero in his past, causing them to seek retribution. Either Pierce, unbeknownst to Oedipa, implicated his then-lover into the conspiracy as a sort of scapegoat, or, perhaps, The Tristero is seeking to harm all of Pierce's loved ones out of spite. In any scenario, the ending is the same: The Tristero mercilessly attacks Oedipa with entropy until she is on her knees.

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[42] Once again, it is unknown how many seizures visit Oedipa throughout *Lot 49*, but Pynchon hints that there have been many. As a fun side note here, Oedipa is probably suffering from temporal lobe seizures, as they are most often associated with complex hallucinations like Oedipa's "revelations" (Vignal et al. 88; Bien et al. 244).

[43] Seizures are also fatal in reality. People who suffer from epilepsy have up to a 4x greater risk of dying in their lifetime than average because of the physical dangers associated with continued seizure attacks (Shorvon et al. 28).

The Tristero may be a good for society overall, injecting some sort of change into the otherwise menial day, but for Oedipa, they increase her system's entropy and stress her to her breaking point of heat death.[44] In this extended sense, no revelatory communication occurs at all. Just as Oedipa is unable to communicate with Maxwell's Demon to provide its system with external energy, her seizure revelations are unable to provide her system with external energy. Entropy is continually rising in *Lot 49,* and although Oedipa may not yet be in a total heat death state by the end of the novel, she is progressively moving toward that point through multiple neuroscientific means. *The Crying of Lot 49* is a novel about the catastrophic impacts of neurological disorders and the entropic connections they foster. Because of neurological mechanisms malfunctioning, entropy rises unto heat death, and no communication can happen. This neurological break, whether created on purpose or not, is propagated by the Tristero and provides the precursor milieu for an isolated system prone to heat death.

As we move into the concluding chapter of this thesis, keep in mind all the neuroscientific ideals already presented. *Lot 49*'s entire story can be read as an extended metaphor of then-current neuroscience. Primarily, however, *Lot 49* is a cybernetic exploration into the then recently elucidated neuronal action potential and the oscillatory activity of neuronal assemblies it subsequently provides. *Lot 49* represents both the cybernetic workings of a single neuron and the entire nervous system in a seamless encapsulation of cybernetic neuroscience and its communicative and informatic relations to human society and life.

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[44] I support the argument that the Tristero are an overall *good* force for people "down on their luck" in America and the world. However, for Oedipa Maas, a Californian middle-class housewife who unknowingly and accidentally stumbles into the middle of the Tristero web (whether or not the Tristero set the web for Oedipa to walk into in the first place), they are malicious, and only cause her pain. Oedipa is informatically pummeled by the Tristero until she gets dead drunk (again) and drives "on the freeway for a while with her lights out, to see what would happen" (146). If the fact that Oedipa attempts suicide near the end of the novel because of the Tristero is not enough to concede that they may actually be a bad entity in her life, then nothing will be enough. Think about *Lot 49* as a movie, even. If *Lot 49* was ever adapted as a movie it would be a *horror movie* through Oedipa's eyes, all because of the Tristero.

Conclusion: Hodgkin and Huxley's *Lot 49*

In a novel where the main bar, The Scope, features a "green neon sign outside ingeniously [depicting] the face of an oscilloscope tube, over which flowed an ever-changing dance of Lissajous figures," and in the backroom stores "audio oscillators, gunshot machines, [and] contact mikes," there is something neuroscientific happening, to say the least (Pynchon 34). Lissajous figures "are the curving patterns formed by two-dimensional oscillations. They are most readily observed on the screen of an oscilloscope when electrical signals are applied across its horizontal and vertical inputs" (Grant 48). They are two-dimensional electric oscillations just like what neurons produce when they fire action potentials. An oscilloscope, a device for testing electrical equipment, measures change in voltage on the Y-axis over time on the X-axis ("Oscilloscope"). In neurons the action potential is recorded as changes in voltage on the Y-axis versus time on the X-axis. The Scope, as an establishment, represents one big neuronal action potential!

Bars are places that people go to talk to each other, communicate, and drink, and the Scope is associated with the Yoyodyne plant and its workers. Of course, Oedipa and Metzger perform just that when they visit The Scope: Metzger orders a bourbon, which Oedipa drinks, while "everyone inside [was] drunk already" (Pynchon 34).[45] Soon, Oedipa and Metzger begin to communicate with Mike Fallopian of the Peter Pinguid society about the American Civil War. However, the real communication phenomenon happens outside their conversation, as a "fattish pale young man" appears "carrying a leather mailsack over his shoulder" (Pynchon 37). The fat man yells "mail call" and starts "throwing envelopes into the crowd" (Pynchon 37). Fallopian runs over to receive his mail, which is from "Yoyodyne's inter-office delivery" system (Pynchon 38).

[45] Perhaps the Scope patrons are attempting to decrease their information entropy to communicate better.

The Scope's Lissajous figures reference the establishment as an action potential, which is supported by the fact that its inter-mail system (probably connected with W.A.S.T.E.) mimics a nervous system of untold billions of neuronal action potentials. The people and mail inside The Scope are neurons sending their individual action potentials as mailings, which collectively come together to create one giant nervous system of a mail delivery system.[46] In this sense, there is a constant feedback loop of The Scope patrons receiving mail information, processing received mail information, and then reacting to said information by sending their own mail (signals) to each other in real time to keep the system optimally running or "firing" for the future. The Scope presents a cybernetic nervous system whose feedback mechanisms are operating correctly; an ideal that is not realized for Oedipa later as her seizures and alcoholism intensify.

As this final example indicates, *The Crying of Lot 49* is a work about neuroscience as much as anything else. The entire novel is an extended metaphor for the neuronal action potential and its cybernetic communication of information. Neuronal action potentials communicate electrical information through cybernetic feedback loops, therefore performing a negentropic process. Oedipa, in *The Crying of Lot 49*, needs just that type of process. Oedipa requires an external energy source to defy entropy and break into her isolated system to restore order.[47] The neuron is the perfect structure for this task; not only is the neuron a biological construct and thus naturally

[46] The fact that there is a W.A.S.T.E/Yoyodyne mail system and a U.S. mail system, or perhaps even a W.A.S.T.E. system, a Yoyodyne mail system, and a U.S. mail system, speaks to the neurological phenomenon of parallel processing. Parallel processing is "a mode of computer operation in which a process is split into parts that execute simultaneously on different processors attached to the same computer" (Oxford English Dictionary). Parallel processing occurs in the brain and nervous system through the ability of the brain to process different incoming stimuli at the same time (Wässle 1). Both these streams of neuronal action potentials still need to keep up cybernetic processes to communicate with the brain and thus maintain its health. Therefore, the U.S. mail system, the W.A.S.T.E. mail system, and possibly others, can be understood as parallel processes of different bundles of neurons in the same nervous system, systems that are still dependent on the shared need for cybernetic feedback loops.

[47] Remember: Oedipa is in an isolated system because Oedipa is the Demon, which is in an isolated system itself. The plotline of *Lot 49* only makes sense when operating in an isolated system, which needs an external energy source to refresh its entropic rise. *Lot 49*'s entropy increase explicitly manifests itself in the world through intensifying blandness of landscape, corruption of communication, sameness of symbols, etc.

decreases entropy, but it also defies entropy in its actual shuttling of energy information. Although Oedipa is obviously also a biological system with a nervous system and consequently defies entropy through cybernetic processes, her system and the entire world of *Lot 49* still increase in entropy. This rise in entropy still occurs despite Oedipa's nervous system's natural inclination towards negentropic information because Oedipa, and everyone else, are in an isolated system. In an isolated system, negentropic cybernetic feedback loops are of no consequence; the system will still increase in entropy unto heat death.

Because Oedipa is in an isolated system, the neuronal action potential soon breaks down in *Lot 49* as its cybernetic feedback loops go haywire. With the neuronal action potential and its associated cybernetic feedback loops faulty, the neuron cannot communicate its information correctly. The neuronal action potential is no longer negentropic but, instead, *entropic*. The action potential still attempts to "break through" into Oedipa's world and provide information energy, but only to bring about a malignant end for Oedipa. Instead of infusing concise information energy, the neuronal action potential gives seizures. These phenomena are consequences of the negentropic cybernetic feedback loops of the neurons messing up, steering the "ship's rudder" off course in their continued efforts to stabilize. What disturbs these cybernetic feedback loops is the Tristero, who place too much semiotic stress on Oedipa with all their symbols. The Tristero, therefore, break Oedipa's negentropic information communication system through excess information in the form of excitatory neuronal action potentials, which disrupt their normal feedback processing. The Tristero not only directly raise entropy through their semiotic information, but also bar the infusion of external energy into an isolated system by unsettling the nervous system's negentropic communication of energy with "revelatory" seizures. The Tristero thus neurologically cause the heat death of *Lot 49*.

Considering that neuroscientific scholarship, both scientific and humanistic, was exploding in the 1950's and 1960's, it would make less sense if Pynchon did *not* have any neuroscientific phenomena in *The Crying of Lot 49*, especially when considering his love for Wiener. *The Crying of Lot 49* is a seminal postmodern novel, a reflection of America and the world after World War II. During the 1960s, Pynchon was well aware of "the spirit of the times" and wrote his reflections beautifully in *Lot 49*. Politically, religiously, historically, philosophically, it is all there: the solemn contemplating of World War II, Cold War fear, Religious questioning in a contemporary world, and the hopeful yet paranoiac look towards all the future possibilities of the 1970's and beyond. Scientifically, the reflections are there, too: the revolutionary, scary, and complex new sciences of cybernetics, information theory, and modern thermodynamic physics are in *Lot 49* like a historical time capsule, a look into what people at the time thought about these advancements.

Neuroscience, like all other groundbreaking mid-20th century sciences, did not pass over Pynchon's head, and neither did one of its greatest discoveries. Neuroscience, being a part of the "spirit of the times" during the mid-20th century, is therefore heavily reflected in *The Crying of Lot 49*. Although the cybernetic neuronal action potential, inarguably the most outstanding neuroscientific achievement up that point in 1966, is most prominently displayed in *Lot 49*, many fundamental aspects of neuroscience separate from information theory and/or cybernetics are present as well. Lissajous figures, LSD hallucinations, Freudian psychology, brain circuitry, and neurological antenna symbolism all indicate that Pynchon knew about and was interested in playing with this new and fun field of neuroscience. Moreover, the fact that neuroscience is implicated in the nightmare heat death that threatens Oedipa suggests that, as with the sciences of cybernetics and information theory, there was much anxiety about where neuroscience would take humanity into the rest of the 20th century.

The Crying of Lot 49 can thus be read as a postmodern reflection of its neuroscientific time. Postmodern literature and neuroscience both originated with a bang directly after World War II. Neuroscience and postmodern literature furthermore had huge impacts in the mid-20th century that still greatly affect us today. The implications of postmodernism's and neuroscience's mid-20th century impacts are reflected in *Lot 49*, an archetypal postmodern novel that concerns neuroscience. Thus, in many ways, postmodern literature and modern neuroscience grew up together. The birth of their relationship, moreover, occurred in *The Crying of Lot 49*.

If the current scientist, literary scholar, historian, or lay reader wishes to know how neuroscience has evolved into its prestigious form today, then they can look no further than *The Crying of Lot 49*. Through *Lot 49*'s reflection of emerging neuroscience, the reader can trace the evolution of neuroscience and the associated cultural opinions about it up to the present day. Now in 2020, neuroscience is a behemoth of a field. However, this behemoth of a field would never have gotten to this point if it were not for key mid-20th century neuroscientific discoveries by scientists like Hodgkin and Huxley. Pynchon was writing about these neuroscientific topics right when they were discovered in the mid-20th century in books like *The Crying of Lot 49*.

To learn and understand how neuroscience has reached the elaborate modern form it has, the popular thoughts on neuroscience during its genesis, the early anxieties related to neuroscience, how neuroscience is reflected in postmodern literature, or simply about the philosophical as well as scientific sides of neuroscience, read *The Crying of Lot 49*. There is a reason, that, when she visits John Nestafis, "a retinal twitch, a misfired nerve cell," causes Oedipa to realize she is not actually communicating with the Demon; that her communication of external information energy into the Demon's isolated system fails toward heat death (Pynchon 86).

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