Systems Medicine and the War on Cancer
A New Materialist Analysis

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The request to redefine the role of materiality in social studies and philosophy is one leading trend in current scholarship. There are many terms dedicated to the excitement around the issue of materiality: new materialism, object oriented ontology (OOO), actor network theory (ANT), and speculative realism being probably the best-known references. Though these fields hardly represent homogeneous viewpoints, they all differentiate themselves from previous scholarship on the basis of their perspective on material ontology by highlighting the impossibility to view materiality and culture as distinct analytical spheres. As Iris Van Der Tuin and Rick Dolphijn emphasize in their article "The Transversality of New Materialism" (2010), the aim of new materialism is to formulate a cultural theory that would not emphasize the role of culture over materiality by seeing it as a discursive creation, nor support a positivist natural science view of matter that could be used as a basis for essentialist and deterministic argumentation. Instead, they highlight the need to talk about meaning production as material-discursive, meaning that while social relations do shape the way in which materiality is perceived, matter itself also takes active part in its materialization (Van Der Tuin & Dolphijn 2010, 153-159).

The question of ontology as it emerges in recent scholarship is not only a metaphysical quandary to be discussed over a nice glass of red wine, but it is also seen as a viewpoint that can help to approach contemporary material phenomena, such as climate change, as well as to better connect with scientific research studying these phenomena. One interesting area of scientific research for new materialists has been systems biology since it was born out of demand to consider organisms as dynamic networks.[1] In this article, I will elaborate on the connectivity between systems biology approach to cancer research and new materialism through a close reading of Michael R. Hendrickson's article "Exorcizing Schrödinger's Ghost: Reflections on 'What Is Life?' and Its Surprising Relevance to Cancer Biology" (2011). I will argue that the vision of the body that contemporary cancer research maintains, which highlights bodily dynamism, complexity, and emergence, is consistent with the new materialist approach to material ontology. However, keeping in mind the new materialist demand on considering knowledge production as material-discursive, I argue that the metaphor of war against cancer, which is still prevalent when talking

[1] As Evelyn Fox Keller points out, "systems biology" functions as an umbrella term to describe new approaches in biological research that, instead of focusing on particular units in the body such as "genes", studies organisms as complex systems, which are also open to environmental factors. See Keller 2005

about cancer research, has a danger of reducing the complexity of this account. By offering a reading on how the war metaphor could be considered as anthropocentric, I will argue that this metaphor does not do justice to the systems biology approach and contemporary cancer treatments. I will suggest, instead, that challenging this metaphor might open up new ways to envision contemporary cancer research.

NEW MATERIALISM, SCIENTIFIC RESEARCH, AND SYSTEMS BIOLOGY

New materialism is a direction in current scholarship that wishes to consider matter as an active participant in meaning production. The term was launched both by Rosi Braidotti and Manuel DeLanda independently in the 1990s to claim a move away from the nature/culture dichotomy in social science. As Samantha Frost points out, the nature/culture dualism was largely criticized by the cultural turn. However, while criticizing the artificiality of this binary division, the cultural turn emphasized the role that culture always had in the knowledge of materiality. Since this often lead to a view of passive matter over which cultural meanings are placed, new materialists try to create a new approach, a new lexicon, to talk about materiality. As described by Frost,

> [New materialists] try to specify and trace the distinctive agency of matter and biology, elucidate the reciprocal imbrication of flesh, culture, and cognition, investigate the porosity of the body in relation to the environment in which it exists, and map the conditions and technologies that shape, constrain, and enhance the possibilities for knowledge and action (Frost 2011, 74).

Diana Coole and Frost state in the introduction of the book *New Materialism* (2010) that one source of inspiration for the creation of new materialism has been the development of the natural sciences in the twentieth-century. They argue that, for example, creations of the chaos and complexity theories in the field of quantum physics have inspired a demand for a new ontology of matter that would replace a vision of substantial material *being* with an image of transformative, fluid and open-ended material *becoming* (Coole & Frost 2010, 10-11). Coole and Frost highlight that the ontological vision of matter that highlights complexity, fluidity, and open-endedness is gaining importance also in the area of molecular biology. They point out that especially since the completion of the Human Genome Project (HGP) the study of organisms has increasingly implemented the vision of the body as a complex system that is also affected by its environment. This was because the HGP revealed that humans have a relatively low number of genes in their bodies, which lead researchers to question how genes operate in a genome-wide context and, thus, they started to approach organisms as complex networks. Coole and Frost name systems biology as one instance of research that has applied an ontological vision of fluid matter to the study of organisms. In other words, for Coole and Frost, systems biology functions as an example of the limits of genetic research that many scientists had to face during the late twentieth century, which led to the new directions in molecular biology (Ibid., 15-18).

Michael R. Hendrickson points out that new directions in molecular biology have influenced cancer research as well. In his article, he traces the history of cancer research from the beginning of the twentieth century to the present. He states that what influenced cancer research greatly was a move away from classical genetics to molecular genetics in 1950s. Erwin Schrödinger and his lecture "What Is Life?" in 1943 played a big part in this change since Schrödinger disassociated his research questions from classical genetics that was based strongly on quantitative experiments that studied the relation between genotype (innate traits) and phenotype (visible characters). While numerous scientists, such as Mendel in his pea cross-breeding experiment, Thomas Hunt Morgan in his fruit fly lab experiment, and Hermann Joseph Muller via radiation studies, tried to understand the relation between genotype and phenotype, the definition of gene remained unidentified (Hendrickson 2011, 53-58). As Morgan noted in his Nobel speech in 1933,

> There is no consensus of opinion among geneticists as to what genes are – whether they are real or purely fictitious – because at the level at which genetic experiments lie, it does not make the slightest difference whether the gene is a hypothetical unit, or whether the gene is a material particle (Morgan cited in Ibid., 55).

In other words, while "gene" was used to describe an elementary unit of heredity, genetic research did not aim to study genes as such. Schrödinger went against this tradition by asking not how the concept of the gene could be used to describe life but how scientists could study "the physico-chemical basis of heredity" in other words, the gene itself (Ibid., 58). Hendrickson points out that Schrödinger's lecture was influential for scientists who started to explore the molecular basis of genetics. This research culminated in the revelation of the structure of DNA by James Watson and Francis Crick in 1953, starting what Hendrickson calls the "heroic age of molecular biology" (Ibid., 61). The central dogma of this age, according to Hendrickson, was the definition of important entities of heredity, such as DNA and RNA, and linear causality that connects these entities together. Consequently, this dogma supported genetic reductionism by situating genes at the center of scientific research on heredity (Ibid., 61-65).

Hendrickson states that during the 1970s, the molecular genetic approach started to influence cancer research since recombinant DNA technology enabled scientists to test cancer theories at the molecular level. Before the 1970s, the term "cancer" was used to describe hundreds of different diseases that were all characterized by an uncontrolled cell growth, and cancer was seen as a cellular disease. Hendrickson notes, however, that "from the beginning of the 1980s a consensus formed that cancer was due to abnormalities in a small family of genes that were thought to be responsible for transforming a normal cell into a malignant cell, which then went on to produce a clinically detectable tumor" (Ibid., 66). While cancer research revealed different kinds of genes taking part in the development of cancer in addition to main oncogenes, such as tumor suppressor genes, Hendrickson argues that cancer research still maintained the reductionist character of contemporary molecular biology by assigning hierarchical and linear causality between lower and higher level properties. This was changed by the postgenomics of the 21st century that challenged the reductionist basis of molecular biology (Ibid.; 66-67, 77-78).

As noted by Coole and Frost, the HGP was one thing that forced scientists to reconsider the foundations of molecular genetics. HGP surprised many by revealing that the number of genes in the human body was much lower than anticipated, which led to the conclusion that genetic diversity was mainly due to complex genome-wide interactions (Rheinberger 2010, 165) . However, as Hendrickson notes in his article, scientists had started to challenge the gene-centered approach in the study of the organism already in the 1980s when more and more information about the complex networks within the genome came to light. Hendrickson calls this new approach "Post-Schrödingerian Perspective" (PSP) and defines it as a viewpoint that "takes levels of organization very seriously" but highlights networks instead of linear relations. Thus, PSP is different from the previous molecular genetic view of the organization of the organism since

> There is no privileged level of examination or explanation … The usual discourse of cause and effect doesn't work for networks. For the simplest network, a circle, we have a chicken-and-egg problem; each is jointly cause and effect. The PSP is *holistic* rather than reductionist. It is not genocentric but locates agency at *all* levels of organization, none of which are privileged. It is, in short, *organism-centered* (Hendrickson 2011, 77-78).

When considering the focus on networks, the holistic approach and organism-centered viewpoint, it becomes understandable why the new materialist scholars wish to highlight the changes that have been happening in molecular biology since the 1980s. I elaborate this point by offering a reading on the ways in which PSP resonates with the assemblage theory created by Gilles Deleuze and Félix Guattari, which has been an important inspiration for scholars such as Braidotti and DeLanda.

Deleuze and Guattari use the term "assemblage" to describe framework with which to understand the world that is chaotic in all its complexity and dynamism but simultaneously comprehensible due to a "rhythm [that] is the milieu's answer to chaos" (Deleuze & Guattari 1988, 313)." This means that while one cannot define stable, unchanging territories in the world, the concept of assemblage allows one to analyze a territory as a coming together of different elements. In other words, it is possible to define certain elements that constitute an assemblage in a given time. However, these components are shaped by both internal and external relations, and, thus, they cannot themselves be considered as unchanging (Ibid., 315-317). The organism-centered PSP seems to be based on a similar principle, since Hendrickson highlights that "new properties emerge at each level of organization, and these can be causally effective both at their own level and at lower organizational levels" (Hendrickson 2011, 77). This statement, together with the previous quotation from Hendrickson, shows that the definition of causality needs to be rethought in relation to PSP. Manuel DeLanda's article "Emergence, Causality and Realism" (2011) can help to elaborate the definition of causality.

DeLanda's notion "mechanism of emergence", similarly to the Deleuzian assemblage, describes a complexity that is not a "seamless totality" but, instead, possible to be divided into singularities (De Landa 2011, 384)[1]. The causality in this emergence, still, cannot be explained as a linear relation between these singularities. Instead, causality comes to represent a "space of possibilities" that can be defined in the limits of the "mechanism of emergence", taking into consideration the singularities within the mechanism without letting the mechanism dictate that singularities should perform in a definite manner (DeLanda 2011, 387-389). When connected to assemblage theory, this vision of causality helps to picture assemblage as a collection of definable, but not stable, elements that all contribute to the territorialization of the assemblage. However, the dynamism of elements, their relation with one another as well as assemblage's connection to other assemblages, makes it impossible to impose linear causality to the emergence of assemblage. This framework of assemblage, I argue, is dominant in PSP as well. As Hendrickson argues "PSP emphasizes the necessity of considering *context, emergent properties, and the importance of the relationship of parts in constructing the whole*" (Hendrickson 2011, 49). The fact that PSP resembles greatly assemblage theory becomes less odd when knowing that both PSP and Deleuze were influenced by similar scientific theories, such as Ilya Prigogine's theory of dissipative systems (Ibid., 82-86)[2].

As systems biology is one example that Hendrickson gives of PSP, it is clear that systems biology is based on similar material ontology as highlighted by many new materialists. However, when talking about the connections between scientific research and new materialism, which considers the material-discursive basis of meaning production, it is important not only to consider the material ontology but also how this ontological view shapes scientific practices. This is important especially since scientific practices are often considered to be reductionist within cultural studies. Deleuze and Guattari, for example, argue in their book *What Is Philosophy?* (1994) that science and philosophy have different kind of connection with the immanent world

[1] DeLanda's thoughts have been largely influenced by Deleuze and, for example, his book *A New Philosophy of Society: Assemblage Theory and Social Complexity* (2006) elaborates on the possibility to use assemblage approach in social studies analysis.

[2] For an account of how contemporary science affected Deleuze's philosophy, see May 2005.

largely due to the scientific methods. Whereas philosophy is able to grasp and understand the immanent world through abstract concepts, science cannot accomplish this since its aim is not to describe the world as such but to locate particular functions in the world in order to answer its questions. Inevitably, this search of functions ends up stabilizing particular variables, thus losing the grasp of the world's dynamism (Deleuze & Guattari 1994, 118). However, systems medicine[1] seems to offer a different kind of vision of scientific research.

Hendrickson states that one reason why systems biology research has taken root in biomedical research is because after PSP it "became clear that to explain cell-level, organ-level, and organism-level function would require putting the molecular pieces of this Humpty Dumpty back together again in a way that preserved their original topology" (Hendrickson 2011, 87. What is interesting in this statement is that it represents scientific research as mapping biological organisms rather than tracing a specific source of explanation. Therefore, systems biology seems to fulfill Deleuze's and Guattari's requirement for acceptable methods when approaching assemblage: "the tracing should always be put back on the map"(Deleuze & Guattari 1988, 13). Still, what it means to implement this kind of method within cancer research poses a more difficult question that I will address by focusing on the metaphor of war against cancer often used when describing cancer research.

WAR AGAINST CANCER

Hendrickson highlights that the emphasis on organism-wide networks that PSP supports made it obvious how difficult it is to control and cure cancer. This is because cancer was now seen not only as individual-based, but research also highlighted that "there does not appear to be a single, specific, fixed stepwise progression from normal cell to malignant cell in most types of adult cancer" (Hendrickson 2011, 94). Also, cancer started to be considered as a "microecological system" where cancer cells not only communicate with one another but with, for example, blood vessels, immune cells, and fibroblasts. Hence treatment targeted at cancer cells might destroy a majority of cancer cells, but since cells are different, it is possible that some cells gain immunity to the drug and, thus, cancer recurs (Idib., 94-95). Thus, Hendrickson concludes his article by stating: "unfortunately, for the foreseeable future, successes in *the war on cancer* will continue to be measured by incremental advances in prevention and in early diagnosis, which is amenable to conventional nontargeted therapies" (Ibid., 103). While the war reference in Hendrickson's text is used to highlight the struggles that contemporary cancer research faces, I argue that this metaphor can be considered problematic when explaining the systems medicine approach to cancer and current practices in cancer treatment. I will elaborate this point by highlighting how new materialist scholarship has criticized anthropocentrism and suggesting that this criticism might be useful also when analyzing discourses around cancer research.

[1] Here I differentiate between systems biology and systems medicine, which is used to describe medical practices that utilize systems approach, for example, when designing drug combinations in the treatment of cancer.

Levi R. Bryant notes in his book *The Democracy of Objects* (2011) that contemporary philosophy emphasizes epistemology over ontology by placing the human at the center of inquiry. This anthropocentrism causes that "claims about being are claims about being for humans" (Bryant 2011, 35). Similarly, Donna Haraway notes that disease studies create a vision of disease as "a process of misrecognition or transgression of the boundaries of a strategic assemblage called self … what counts as a 'unit', a one, is highly problematic, not a permanent given. *Individuality is a strategic defence problem*" (Haraway 1991, 212). Considering individuality in relation with the boundaries for defence in disease studies clearly suggests that defining the boundaries of the human is a starting point from which a disease is defined. Moreover, the language of war, as a *defence* of individuality, supports this human-centered approach to disease.

As Claire Colebrook states, theories about humans have been based on binary sexual difference that has also shaped the ways in which appropriate couplings have been analyzed. As Colebrook notes,

> The fear of sexual indifference – a circulation, exchange and proliferation beyond bounded forms – is precisely that which has imprisoned human species within its logic of self-enclosing sameness … By only admitting the lived differences of bounded kinds we have been unable to consider the difference of lifelines and force lines beyond our purview (Colebrook 2012, 181).

Colebrook's argument is directed against theories that assume the prevalence of sexual difference in a changing world. However, in my mind it also describes well how the connection between humans and cancer is often described: as an unnatural coupling that needs to be broken apart – hence the war against cancer. This is a problematic statement, I argue, for two reasons. Firstly, the assumption that cancer is a definite element attacking the human body is misleading in the light of new scholarship, since it conceals the multiplicity of elements and their complex networking within the human body. As Alphonso Lingis reminds us: "our bodies are coral reefs teeming with polyps, sponges, gorgonians, and free-swimming macrophages continually stirred by monsoon climates of moist air, blood, and biles" (Lingis 2003, 167). In other words, the systems biology approach to cancer should be regarded as a contextual network that is also open to environmental influences. This leads me to a second problem I have with anthropocentrism: the question of the agency of cancer.

If cancer is described as an enemy within an anthropocentric worldview that posits cancer as a participant in an unwanted coupling, it is hardly preposterous, in a world where selfish genes are still part of popular discourse, to assume that this framework entails a question of the aims of cancer. In other words, while cancer is seen as an unwelcome invader, the metaphor of war seems, additionally, to define cancer via the human perspective, in the sense that the human is seen as a distinct entity invaded by an external thing. This externality of cancer shapes its assumed agency as well, highlighting its will to spread despite the harm caused to the human body.[1] This assumption goes against the principles of emergence, described by Manuel DeLanda and supported by systems biology, since in this account it seems that the mechanism (the human body) dictates the function of the singular element (cancer) – though in a negative way in this example. This is not to say that the cancer research could not identify distinct elements that take part in the spreading of cancer, control and even destroy them. However, as Lingis points out, little of the movements inside of the human body are teleological and even "every purposive movement, when it catches on, loses sight of its teleology and continues as a periodicity with a force that is not the force of the will launching it and launching it once again and then once again; instead it continues as a force of inner intensity" (Lingis 2003, 168). Thus, the more cancer develops, the more difficult it is to control or destroy it.

While I wish to use anthropocentrism as a conceptual tool to critically analyze war against cancer discourse, I want to emphasize that my aim is not to argue that systems medicine approach would not aim to cure cancer or to identify singular elements that take part in maintaining and developing cancer. I argue, however, that the human-centered viewpoint can obscure the understanding of the ways in which these singular elements come to be and how they emerge within the human body as an assemblage. As Bryant highlights, within the anthropocentric framework, "being can only be thought in terms of what Graham Harman has called our *access* to being" (Bryant 2011, 35). In other words, when considered via war terminology, cancer research becomes a quest for identifying and destroying cancer. However, this is an example of a case which "is characterized by primacy of epistemology over ontology" (Ibid., 34). As an alternative viewpoint, Bryant presents Roy Bhaskar's notion of scientific research that would not posit humans as "monarchs of being but instead among beings, entangled in beings, and implicated in other beings" (Ibid., 40). This would require not considering which methods would help to locate a certain agent (such as cancer) but, instead, building up methods that would best adapt to ontological reality (Ibid., 47). Bruno Latour's analysis of the experiments with ferment done by Louis Pasteur helps to expand this point.

One of the main messages that Latour gives in his account of Louis Pasteur's work is that science studies need to abandon the assumption of a dichotomy between speaking human and mute world (Latour 1999, 140). Instead, Latour suggests considering scientific experiment, which aims to locate an unknown reason for a particular action, as an event that consists of three different trials. In the first one, scientists need to identify the action they are studying and the research object that takes part in this action. After this, scientists need to represent their findings to their colleagues to test their analyses. Finally, they present the findings to their scientific

[1] One such account was published in Finnish journal Helsingin Sanomat in August 24, 2013 with a vision of humanized cancer evident already in the title "cancer cell that refuses to die" (Rough translation. Original: "Syöpäsolu, joka ei suostu kuolemaan.")

community that will or will not consider the results as correct. Latour highlights that what is essential to understand in this event is that while the scientists are the ones who name the action they are studying, the actor of the story changes after the first trial to be the research object itself. This is because in order for the scientists to prove their findings to others, the research object cannot be a product of the artificiality of the laboratory (Ibid., 122).

This requirement of non-artificiality of the identified material object leads Latour to state that the lactic acid ferment, which Pasteur identified with his experiments, is independent of human construction while at the same time it has no existence outside the work done by Pasteur. It then follows, according to Latour, that experiment should not be considered negatively as an artificial context but rather as something that can allow material objects to exist (Ibid., 139). While Latour's argument might sound even contradictory, it is graspable when considering his main criticism towards the tendency to draw a strict line between humans and the world: while it might be the scientists who create the artificial stage for the object to exist, scientists do not create the objects of their studies. As such, Latour's example illustrates how scientific research can be seen to posit ontology prior to epistemology: even though the scientific experiment would fail to adapt to the material ontology it aims to study and thus misidentify the research object, the experiment or the scientific community would inevitably point this out. This is not to say that what scientific community dictates is the truth — after Thomas Kuhn's analysis of scientific community and "normal science" hardly anyone would argue that — but that scientific experiment, even when its aim is to locate a certain agent, does not inevitably equate as reductionist.

In short, I have wished to point out how the 'war against cancer' discourse can create a view of cancer research as anthropocentric, and that this poorly represents a systems medicine approach to cancer. What is more, within the framework of war, Hendrickson's dispiriting conclusion is well put: instead of glorious victory over the enemy, the success of cancer research can only be "measured by incremental advances in prevention and in early diagnosis" (Hendrickson 2011, 103). However, I would like to suggest that disconnecting the assumed success of cancer research from the metaphor of war might help to better explain how the systems biology approach can and has influenced cancer treatment.

Systems Biology and a New Approach to Scientific Practices

Within the framework of ontology-oriented research, I would like to return to the question of how the systems medicine approach to cancer research could be connected with the ontological basis of systems biology. As stated previously, systems biology approaches cancer as an emergence of a multiplicity of singularities in genome-wide context. If the aim of the research and treatment is to defeat cancer, as military metaphors lead us to envision, this complexity often results in defeating outcomes, especially if cancer has had time to spread. While I do not want to dismiss the importance of the aim of curing cancer altogether, I argue that focusing on this aspect of research can hide the fact that the individualized approach to cancer, supported by the systems medicine approach, means also that a lot of research is dedicated to balancing the bodily functions during cancer not only to secure treatment but also to offer a better life quality with cancer and less invasive treatments. I argue that it is this side of the research that is done in co-operation with clinics, and is often left without much hype, where the systems medicine approach can show its strengths since treatment requires comprehending the bodily states and trying to adapt medication and other treatments according to this. For example, kidney dysfunction might require additional drinking of liquids.[1] While this kind of treatment can also be seen in a framework of war against disease in a broader sense, the metaphor of war in its anthropocentrism seems to prevent the possibility to understand, by creating a vision of cancer as an independent enemy, cancer as something that *is* the body with which cancer patients live.

While it might be difficult not to place curing cancer as the main aim of cancer research, I argue that seeing treatment development as a "second prize" in cancer research can also obscure one crucial element in systems medicine approach — the entanglement of theory and practice. As Evelyn Fox Keller points out, biological research has long been based largely on the experimental study of organisms and has avoided the formation of broader theories that would explain biological functions. Keller states that such an approach differentiates biology from physics, where theory and practice have more easily fused together in fields such as quantum physics (Keller 2002, 1-3). Keller sees systems medicine as research that brings together different scientific disciplines, such as mathematics, biology, chemistry, and computer science and thus "the net effect [of this co-operation] is the beginning of an entirely new culture that is at once theoretical and experimental" (Keller 2005, 7). New treatment plans are an essential part of this co-operation as a site where questions of ontology are brought into research practices. Thus, I wish to challenge the war against cancer discourse not only because it can produce an anthropocentric view on cancer but also because it offers a poor representation about what is actually occurring in current research, since developing new treatment plans can be considered a part of knowledge production that can provide better understanding of the dynamism of cancer. I suggest that critical approach to this metaphor is needed in order to comprehend different kinds of aims that are associated with cancer research and that utilize systems biology approach.

[1] In a similar manner, while not a cancer study, an interesting study was published few days ago (January 11, 2014) in *Helsingin Sanomat* about a medical study done in Kuopio University that proved that certain food products can help to slow down the development of Alzheimer's disease since they provide nutrients that the disease is consuming.

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