Chapter 5
Complexity, Reductionism and the Biomedical Model

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5.1 The Biomedical Model of Illness

Up until the nineteenth century, illness, health and recovery were mysterious matters. Infections, cancer and disease in general were understood as some sort of invading curses, leaving little space for rational treatment. It was only with advances in biological knowledge, such as the development of cell theory, the germ theory of disease and bacteriology, that definite explanations of illness, suffering and death could be formulated. The work of influential scientists and physicians, such as Rudolf Virchow, who is sometimes considered the father of modern pathophysiology, had a revolutionary impact on medical thinking. Virchow introduced the idea that every pathology arises from a damaged cell, which paved the way for the work of Robert Koch and Louis Pasteur, as well as for the development of the first theories of the onset of cancer from a malfunction of host cells. By identifying the origin of disease with a malfunction at the simplest structural and functional level of organisms, the cell, this new paradigm allowed us to conceive of new ways to target the causes of disease, for instance by pharmaceutical interventions.

There is little doubt that the discovery of antibiotics and other drugs changed the course of human history. The consequences of these revolutionary developments, however, go beyond the practical outcomes. There was also a deep change at the cultural and conceptual levels, namely in the way illness and health were understood. The *biomedical model of illness* became the dominant paradigm until the end of the twentieth century.

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5.1.1 Reductionism in Medicine and Science

Within the biomedical model, an illness is always explained with one or more physical malfunctions at a lower level of organisation. For instance, an infection is explained with the invasion of parasites, a metabolic disorder with a genetic mutation, a psychiatric disorder with an imbalance of neurotransmitters, a speech impairment or a physical disability with neuronal damage and so on. In philosophy, the idea that a complex phenomenon is best understood by analysing its physical parts in isolation, is called *reductionism* or even *physicalism*.

There are many versions of reductionism (for an overview, see Dupré 1993, part II). The version that we are concerned with here is ontological reductionism. According to this view, the world is thought to only have one causally potent level, namely the physical one. Any non-physical phenomenon would then be nothing but the effect of lower-level causes. This idea of reductionism can be seen in the standard hierarchy of the sciences, where physics is the fundament. Above physics is chemistry, then bio-chemistry, biology, psychology and finally on top, social sciences.

Typical for this hierarchy is that for each higher level, more complexity is introduced. Societies consist of people with individual minds and brains, consisting of cells and tissues, which consist of genes, which again consist of molecules and atoms. Ontological reductionism is thus depicting the different levels of existence in a part-whole relationship, where all higher-level phenomena are composed of the levels below (Figs. 5.1 and 5.2).

Medicine might then be placed between biology and psychology, where the complexity of the human mind is treated separately from the body. This distinction is manifested in the way healthcare services are divided into treatment of the psyche (psychotherapy) and treatment of the soma (medicine). A dualist would say that psyche and soma are separate, but equally real, while a reductionist would try to explain psyche as a result of somatic causal processes, such as biochemical

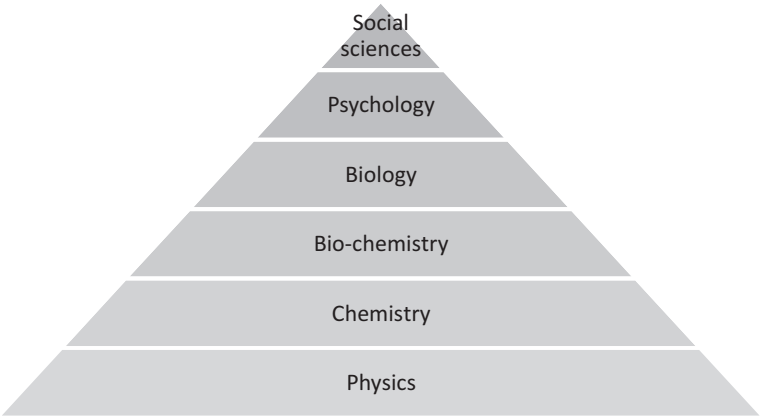

Fig. 5.1 The hierarchy of science

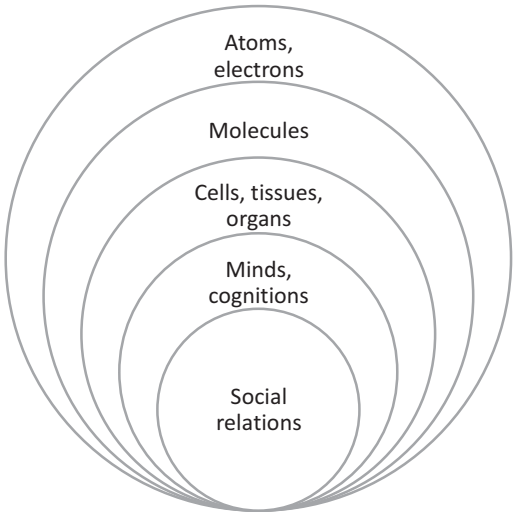

Fig. 5.2 A Venn diagram illustrating a reductionist ontology of wholes and parts

interactions. Psychopharmaceuticals, for instance, target psychiatric phenomena as biochemical processes gone wrong. But this is only one way in which reductionism is manifested in the field of medicine.

Another case of reductionism is medicalisation, which is the tendency to treat existential issues and life events as medical ones, and then exclusively as biomedical problems. Instead of feeling shy, one might have social anxiety, for instance, and instead of grieving the loss of a family member, one might be depressed. In some extreme cases, healthy human responses to inhumane life conditions, such as severe childhood trauma or sexual abuse, are defined as psychiatric disorders and approached primarily from a biological perspective (Kirkengen and Thornquist 2013). Once a problem is characterised as a biomedical problem, one will naturally start to search for a biomedical solution to it. As we shall see, this is one of the reasons why the biomedical model has been criticised for being reductionist, and for ignoring important aspects of what it is to be a healthy human being (Getz et al. 2011).

Simply put…

Reductionism is the philosophical idea that all higher-level (e.g. social, mental or medical) phenomena and processes can in principle be explained at a lower level (e.g. biology, chemistry, physics). Ontological reductionism states that all processes and events must ultimately be the result of physical causes.

The biomedical model brings about some specific ways to understand health, illness and disease. First, illness is always reducible to a physical, biological disease. It concerns purely the physical body, which is seen as analysable into separate

parts. This is a mechanistic view of biology, in which parts are not changed by the context, and therefore can be studied in isolation, as one would do with a car engine, for instance. The mechanistic view, together with the dualism that separates body from mind, are deeply set in the Western culture, mostly because of the influential work of René Descartes (1641).

Another idea introduced with the biomedical model is a specific understanding of 'health', which is seen merely as the absence of physical signs of disease. As a result, curing a disease is exclusively a task for medical professionals and medical technology, while the patient is only a receiver of such cures. The biomedical model has an intuitive appeal for many types of conditions, such as bacterial infections. But for a long time this view was taken as generally valid for medical science. Also, the biomedical approach acquired a normative connotation. This means that the orthodox medical thinking has been to consider the most 'scientific' medical intervention to be the one based on the biomedical model. This frame of mind, as we will see, has been widely criticised in the last few decades. Nevertheless, the biomedical model is so influential and deep-seated that it has survived and is still the prevailing view in medicine.

For example, although Attention Deficit Hyperactivity Disorder (ADHD) is diagnosed in children as an alteration of their behaviour, mainstream medicine explains the condition as a neurobiological disorder (cf. DeVreese et al. 2010). As a consequence, the main therapy for ADHD is pharmacological psycho-stimulation, although the precise biological mechanism of such intervention is at the moment unclear. A public health study revealed that children born late in the year were more likely to receive an ADHD diagnosis than those born earlier in the year (Karlstad et al. 2017), suggesting that lack of school maturity in the younger children might be an important causal factor. If so, the symptoms interpreted as an intrinsic neurobiological disorder, ADHD, might actually be the effect of social and contextual factors.

5.1.2 Critical Reflections Concerning the Biomedical Model

The limitation of the biomedical model has been highlighted by many, already since the 1950s. The main criticism is that illness is a condition of the whole person, and treating the patient's bodily parts in separation might alleviate some symptoms without solving the source of the problem. This became increasingly evident with the epidemics of chronic illnesses and metabolic disorders due to an unhealthy lifestyle in Western society, such as diabetes, obesity and cardiovascular disease. Medicalisation without a thorough intervention at the social and psychological level has not been successful in solving these conditions (see for instance Hagen, Chap. 10, this book).

Another criticism of the biomedical model is that it objectifies the patient and reduces them to a passive target of therapy, rather than seen as an active (and the most crucial) actor in healing. As Stephen Tyreman noted, 'patient' is the opposite

of 'agent', and a loss of agency is experienced as illness (Tyreman 2017: 277). This suggestion of a lack of agency is why many person centred practitioners insist on avoiding the term 'patient' and prefer 'person' instead. This also signals a holist view where the person is a subject and not primarily seen as an object of illness (the damaged knee, the hurting back, the malignant tumour), as they are within a reductionist view. Finally, the biomedical model fails to account for all the conditions under which a patient is in fact ill, but without presenting any physical or biological sign of dysfunction. Such is the case for the medically unexplained symptoms or syndromes that we discussed in Chap. 4. These are also referred to as medically unexplained *physical* symptoms (MUPS).

Modern medicine, therefore, is faced with a contradiction by which scientific advances and medical technology offer the best opportunities ever, but at the same time an increasing number of patients are over-medicalised, over-diagnosed, become chronically ill, do not find a place in the health system, or feel that they are not met as whole persons in the healthcare system. The biomedical model seems to have played a central role in this development.

In the CauseHealth project (described in Chap. 1), we have seen that people who experience medically unexplained symptoms often become victims of the biomedical model. Since burnout was not generally accepted as a medical diagnosis until the WHO declared it a diagnosis in 2019, individuals with burnout face the societal stigma of being thought of as not 'really ill, but just lazy' (Engebretsen and Bjorbækmo 2019). However, the lack of a biomedical cause also results in a financial burden for patients without a diagnosis, since one might then not qualify for economic compensation in case of long-term sick-leave (Engebretsen 2018). One obvious solution for helping this patient group is to find a symptom or diagnosis that is already recognised by the healthcare system. While this might solve some problems, it might also create some new ones. Psychotherapist and researcher on burnout, Karin Mohn Engebretsen, has seen how the biomedical model motivates the choice of treatment of people suffering from burnout.

> A matter of debate is whether burnout should be considered a distinct medical diagnosis or a form of depression. Recent research has suggested that public health policies should focus on and medically treat one of the core symptoms, which is asserted to be depression. The preferred medication is selective serotonin reuptake inhibitors (SSRI). A problem, however, is that these patients, referred to me by their general practitioners, often complain about worsened symptoms that might be a side effect of the medication they are on.
>
> Although burnout and depression have similar symptoms, my experience is that there may be substantial differences on the underlying psychological process. I experience the patients grieving a loss quite differently from patients being ill due to an overwhelming life situation. Treating the symptom without any idea of the underlying process in this case might provoke serious trouble. For instance, as some research pointed out, SSRI can lower cortisol levels and therefore worsen the symptoms in stress-induced conditions, possibly through interfering with hypothalamic-pituitary-adrenal axis functioning. Therefore if burnout, as we can reasonably suppose, is a stress-induced syndrome, SSRI can hurt much more than they can help.

> To increase the knowledge of burnout as a phenomenon, complementary research methods are required. Person centred healthcare and the Biomedical Model represent two central methodological perspectives that constitute the main camps in contemporary medical and social science. They depict two extremely different ways of studying social phenomena and as such, they may complement each other. Instead of limiting the medical model to specific biological factors, I argue that it is necessary to include the entire human being within a contextual setting to be able to understand the underlying mechanisms. So to improve the healthcare system related to medically unexplained symptoms it is due time to open up for a philosophical reflection on what research questions we need to answer and choose the methodology that will provide these answers.
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> Karin Mohn Engebretsen, 'Are we satisfied with treating the mere symptoms of medically unexplained syndromes?', CauseHealth blog (https://causehealthblog.wordpress.com/2017/03/27/are-we-satisfied-with-treating-the-mere-symptoms-of-medically-unexplained-syndromes/)

By translating burnout into depression (seen as a biochemical imbalance in the brain), one effectively reduces a complex psychosocial phenomenon to one of its medically accepted symptoms. The serious problem arises when burnout is then treated medically, as if it was actually *caused* by depression.

5.2 The Bio-psychosocial Model of Illness

In the second half of last century, George Engel (1977) proposed a new model to understand health and illness: the bio-psychosocial model. Engel thought that a whole new way of thinking about human conditions was needed. In particular, he found it necessary to acknowledge that not all illnesses are detectable by biological measurements. The bio-psychosocial model embraces all the scientific advances underlying modern medicine, while also highlighting that many conditions cannot be explained by detecting changes at the cellular or molecular level.

For instance, infants who do not receive care and attention from adults might not develop correctly, although all the other physical needs are met. Similarly, patterns of recovery after heart surgery in children are dependent on relationship and communication with family, and even vary depending on whether or not patients have animal companions (Ellis 2012). In these cases, although there are changes at the cellular and molecular level, such changes do not provide a causal explanation for the developmental disruption. Instead, the changes at the lower level of biological organisation are caused by higher level phenomena: in these cases, by social interaction. It is by intervening at this higher level that one can really influence the course of development and recovery.

The bio-psychosocial model aims to introduce to medical and healthcare practice the concept of downward causality, or top-down causality. This is the concept by which causality travels from the higher to the lower level of organisation. In other words, the whole can sometimes cause a change in its parts. Consequently, it is not possible to understand the causal story by analysing the parts in isolation.

Simply put…

Bottom up causality means that the direction of causality goes from causes at a lower level or organisation to effects at a relatively higher level of organisation, while top down causality goes from causes at a higher level of organisation to effects at a lower level of organisation.

Example: a headache can be caused by hormonal fluctuations (bottom up) or by financial worries in times of economic recession (top down).

There are frequent examples of this in medicine: cases in which the social and psychological well-being of the patient influence her physical state are well known to every clinician. Resilience and motivation of the patient, for instance, are often seen as important ingredients for a medical intervention to yield the desired result. This is why, according to Engel and many others in the last decades, a biomedical model, based on the exclusive treatment of physical constituent parts, cannot provide the correct concept of human suffering and healing, and consequently cannot guarantee effective healthcare. Rather, medicine needs to be informed by a more complete understanding of health and illness, which better depicts the reality of human conditions (Loughlin et al. 2018).

Since its original formulation, the bio-psychosocial model had a considerable influence in medical practice, research and education (Farre and Rapley 2017). However, it has also been the object of controversies and criticism. One problem with this model is that it is vague in the formulation of a method for collecting the relevant biopsychosocial information (ibid.). As an amendment to this, some scholars proposed the phenomenological model, the necessity of understanding the patient and the use of narratives as a clinical tool (Greenhalgh and Hurwitz 1998). We already discussed the value of these tools for the causal enquiry in Chap. 4.

Another criticism is that the bio-psychosocial model is very difficult to put into practice in the current medical community. In the context of today's extremely specialised medical education, which practitioner is trained to catch all three levels in depth? The most realistic picture is the one in which different professionals care about different levels: the physician about the biological, the psychologist about the psychological, and the social caretaker about the social. We see, then, that rather than achieving a truly integrated analysis like the one originally proposed by Engel, the whole person is again separated into different levels of complexity, and such levels are likely to be analysed and treated in isolation from each other (Kirkengen 2018).

5.2.1 *Bottom Up and Top Down Causality in Medical Research: Two Views on Cancer Aetiology*

We already mentioned how there can be top down or bottom up explanations of causality. The choice of direction will necessarily affect how we think of causality in medicine. Bottom-up explanations typically look for medical causes at the physical level, while top-down explanations will emphasise higher level causes of illness, which might include contextual, psychosocial or ecological dispositions.

Let us look at a concrete example of these competing views from the field of cancer research. There are two competing theories about the onset of cancer. The first, the somatic mutation theory (SMT), is based on bottom up causality, in so far as it identifies molecular entities as the initiating causes of cancer. An early version of this theory was first stated in Weineberg's 1998 book *One Renegade Cell*, where the author proposes that cancer is originated by a single genetically mutated cell. This extreme form of genetic reductionism was reformulated when knowledge about the complexity of cancer was still developing. Today, the SMT theory postulates that there are several types of mutations that can result in cancer, and such mutations are always altering the communication between one cell and its environment. For instance, a carcinogenic cell loses the ability to react to anti-growth signals from the environment. Still, this view is based on bottom up causality, because it identifies some causes at molecular level which modify higher organisation levels, such as the tissue.

A competing view is the tissue organisation field theory (TOFT), formulated in 1999 by Sonnenschein and Soto in the book *Society of Cells*. Causality here works in a top down process: from the tissue to the cell. According to the theory, it is the disrupted tissue that provokes a change of environment and consequently a change in the cell phenotype, from regular to carcinogenic. Cancer, then, would be a developmental illness, because it would derive from a failure in tissue development. Cells would change their phenotype because of a change in their environment (the tissue), and not primarily because of a change in their components (genes, for instance).

Lately, scientific insights on the epigenetic regulation of the cell phenotype are used to understand cancer. For instance, the relapse after cancer pharmacological therapy is not necessarily due to the presence of a randomly mutated cell since before the therapy. This very Darwinian interpretation, where the mutated cell is passively selected, has been questioned (Pisco and Huan 2015). Instead, cancer cells might change their phenotype independently from a genetic mutation, and as epigenetic adaptation to the environment. If this theory is correct, it would highlight that carcinogenic cells adapt actively to changes in the environment.

These different views have profound consequences for the way cancer is understood, but also for how it should be treated. A bottom up view of causality is thus one of the ontological assumptions that tacitly influence medicine both theoretically and practically.

5.3 The CauseHealth Approach: Change Must Start from Ontology

Although the bio-psychosocial model is a step in the right direction, we said, healthcare needs to move beyond it. The model starts with the quest for a more holistic view of health and illness that does not reduce human conditions to merely the sum of their constituent parts. Still it ends up with the fragmentation of the biological, psychological and social dimensions. Is it possible to reach a genuine integration among these three dimensions of humanity, and if so, how?

In the philosophical framework so far presented (see Chaps. 1, 2, 3, and 4), we promote a view by which any genuine change in the practice and the norms of science must start from the revision of the underlying concepts motivating such practice and norms. The way we think about complexity, causality and probability, for instance, is going to affect what we consider to be the best method to study them. Scientists and practitioners often lament the shortcomings of a certain methodology and try to improve it. However, if this improvement does not start from an update of the most fundamental basic assumptions about the reality to be investigated, the methodological improvements will not be very radical.

In other words, a genuine change in scientific and clinical approaches must start from the most fundamental level to the practical one (Fig. 5.3).

Norms of science are here understood as the norms for the 'correct, systematic acquisition of empirical knowledge' (Anjum and Mumford 2018). Note that the norms we refer to in this context are restricted to epistemology: norms about how researchers and practitioners should best collect and process empirical knowledge. These norms differ from the ethical norms, such as for instance autonomy, justice and equality. The reason why we highlight the relevance of epistemological norms of science in this context, is that any practice that falls outside of an established norm of science is likely to be considered unscientific and met with scepticism. We see then that, in order to change practice, one must first make a more radical change

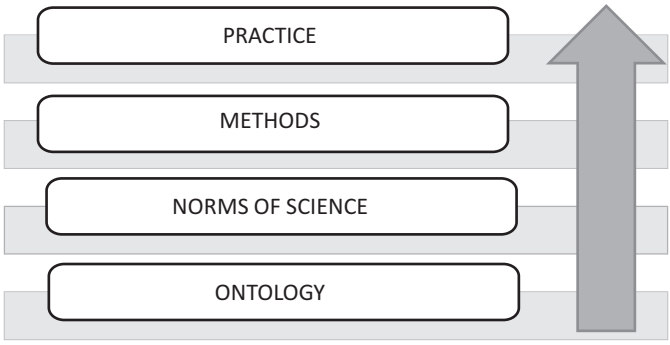

Fig. 5.3 A change in methods and practice must start from a change in ontology

in the norms of science that motivates this practice. Norms of science, in turn, depend on basic ontological assumptions about concepts such as causality, complexity and probability.

Ontology concerns basic implicit assumptions and such assumptions are always present in any type of science, including in medical practice. In the paper 'Philosophical bias is the one bias that science cannot avoid' (Andersen et al. 2019), we argue that such basic implicit assumptions are a necessary prerequisite for any practice informed by science, and for science itself. However, in times of what Thomas Kuhn (1962) calls 'normal science', there is little talk about such assumptions, which remain tacitly and commonly accepted. It is only in times of paradigmatic changes that scientists and practitioners start to talk about ontological basic assumptions and critically discuss them.

One example of such discussion at the ontological level is the criticism of the reductionist and dualistic view of human biology, and the call for a renewal in which human conditions are conceptualised as *complex* and *emergent* phenomena. But even if such critical discussion has been ongoing for many decades, we think that there is still conceptual and fundamental work to do to inform a genuine change in clinical practice. A foundational change in ontology ought to lead to a change in norms and practices, and it should also challenge the way medicine and healthcare is organised, managed and financed. If no such change is seen, it might be because our concepts only *sound* new, but their meaning is defined within the old ontology. For instance, there is general agreement about the complexity and multi-causality of pathogenesis of most illnesses, but there is no general agreement about what it means to say that causality is 'complex'. We will now show how a discussion of this concept can be useful for healthcare and for the clinical encounter.

5.4 What Is Causal Complexity and How Should It Be Investigated?

We have already discussed causal complexity (see Anjum, Chap. 2 and Anjum and Rocca, Chap. 4, this book). But we have not said much about what we mean by such complexity. Does it simply mean that there are multiple causes? This seems to be what the term 'multifactorial' indicates. We will now present two philosophical views on complexity. Depending on which of these views one assumes, different norms, methods and practices will follow.

A common way to think about a complex whole is to see it as the sum of many parts, connected by intertwined causal interactions. For instance, the human genome can be seen as a complex whole in the sense that it is constituted by a large number of functional units, the genes, which are linked by an intricate net of causal interactions. One gene can cause or prevent the expression of many other genes, and can in turn be regulated by a number of different others. In order to understand the causal role of single genes within the genome, scientists then isolate the gene from the genome one

by one and study their sequence and their function in different contexts. This practice of isolating one causal factor from its normal complexity is a dominant epistemological norm in science when studying causality. What does this tell us? First of all, it tells us something about how we think of causality, as something that is best established by looking at the behaviour of a single factor in isolation from contextual interferences. Secondly, it reveals something about how we understand complexity.

5.4.1 Mereological Composition

We can illustrate this first view of a 'complex whole' with a simple example. Imagine a construction made with Lego bricks. Depending on the shape of the brick, each brick can bind to one or more of the other bricks. Together the bricks can combine to form different wholes, such as a castle or a ship. But crucially the individual bricks do no change from taking place in the different constructions. The bricks maintain their original properties throughout. We will call this view of complexity, in which a whole does not induce a change in its parts, *mereological composition*.

Mereological composition is an ontological thesis about how parts relate to wholes and to the other parts within that whole. Crucially, the parts are thought to maintain their properties and identity when combined with other parts to form the whole. Mereological composition might also entail the view that wholes can be decomposed into their parts. This is for instance how a car works. One can put the parts together to make the car and then one can take it apart. The parts of the car will be the same before the composition and after the decomposition. How does this relate to healthcare and the clinical encounter?

Simply put…

Mereological composition here means that the whole is the sum of its parts and that, throughout the process of composition and decomposition, the parts remain unchanged within the whole.

Example: a car engine is produced by the mereological composition of its parts.

A criticism of the biomedical model has been that it sees a person in the same way – as a whole that is best understood by studying and treating its individual parts in separation: the liver, the heart, the lungs, and so on. The bio-psychosocial model might end up with a similar assumption if we have to study the biological, psychological and social causes separately and then add up the results. This is not primarily

a shortcoming of the bio-psychosocial model, but of the scientific methodology of isolating and separating each causal factor and studying them independently of their natural context. This scientific approach comes from the ontological assumption of mereological composition.

A genuine whole-ist should not accept a compositional view of complexity, even if the complexity consists in biological, psychological *and* social parts. What does this mean for the clinical encounter? Is the orthodox scientific approach, based on a mereological idea of complexity, the only feasible option? What is the role of biomedical knowledge in the wholistic clinical encounter? Immunologist and psychotherapist Brian Broom has explored this question in depth during his career. He writes:

> So, does this mean that the whole person-oriented biomedical clinician should, in addition to the normative clinical requirements of his discipline, somehow become a skilled psychotherapist, psychologist, social worker, spiritual advisor or whatever, and be required to perform elaborate, expert, systematised assessments normative within each of those disciplines? This is nonsensical and impossible. Nobody can attend to all of this.
>
> The usual solution is of course the multidisciplinary team. But many of these are pass-the-parcel scenarios where each discipline functions narrowly according to the pattern ordained by the modern biomedical model as expressed in each individual discipline. In sum it usually manifests as an additive framework of highly expert clinicians, patients seen from multiple narrow perspectives, a dualistic concept of disease, and a lack of attention to the highly nuanced individual personal life experiences and subjectivity factors or stories that contribute to the development and perpetuation of disease.
>
> Apart from that critique, I actually value multidisciplinary teams, but believe that each of the practitioners in the team need to be functioning in a whole person way. This is possible whatever one's discipline. By adopting a whole person approach each clinician can do a great deal to enhance healing without feeling overwhelmed.
>
> Brian Broom, 'Imagination and its Companions', CauseHealth blog (https://causehealth-blog.wordpress.com/2017/07/03)

According to Broom, multi-disciplinary teams of clinicians, where each clinician adopts a 'whole person approach', is the way forward to enhance healing. The question then becomes: how should clinicians successfully and genuinely embrace the whole person approach? This cannot be done without revising perhaps the most foundational premise of medical research and practice: the way we understand complexity.

5.4.2 Genuine Complexity and Emergence

There is another way to understand complexity than as mereological composition. This is what we will call 'genuine complexity'. On this view, complex wholes consist in parts that interact with each other in a way that also influences and alters the parts themselves in the process. As parts of a whole, the parts are no longer clearly separated in a way that they can easily decompose and compose into new wholes,

with their identity intact. Instead, the interaction of the parts within that whole is what will give the identity to each part. Outside the context of the whole, the parts would not be that particular part with those particular causal powers or dispositional properties. Their causal role is given by their place and interaction *as part of that particular whole*. The molecule of DNA, for instance, has a specific causal power because it is part of a whole cell, and of a whole organism. DNA extracted from the cell has no causal power, and degrades in a short time.

Recall the concept of a mutual manifestation partner (see Anjum, Chap. 2, this book): the same causal disposition in a different context, or whole, manifests differently because it interacts with different manifestation partners. If this is the case, as dispositionalism assumes, then a complex whole can never be completely understood by observing its parts in isolation. On this view, the *interaction* among the constituent parts and the whole is as important for the causal inquiry as the parts themselves. This is also because the result of such interactions cannot be seen as mere composition. Instead, the whole is the result of a continuous and complex process where the parts that interact lose their prior identity along the way. The whole is therefore more than the sum of its parts, or even something else entirely. We can say that the whole is an *emergent* phenomenon. From the perspective of dispositionalism, ontological emergence is the view that the whole has new properties and new causal powers as a result of the causal interactions of its parts, where the change also happens in the parts during this process (for more details on dispositionalist emergence, see Anjum and Mumford 2017). A simple example of this could be water, which has a number of causal powers that are not found in its atomic components. Water is thus the result of a process of change that happens when the atoms interact to form the molecule.

Simply put…

Emergence happens when there are new properties and causal powers of wholes in virtue of causal interactions among their parts. The whole is then more, or something else, than the sum of its parts.

Example: sodium chloride is composed by sodium and chlorine, yet its properties are completely different from the properties of its components.

This way of thinking about complexity is more common in the discipline of ecology, where the interaction between a species (the part) and an ecosystem (the whole) changes both. A beaver, for instance, modifies its surroundings by building a dam. But at the same time, the surroundings modify the beaver by natural selection. For this reason, ecology studies the interactions between species and ecosystems, and would not be interested in studying a species in captivity, isolated from its natural context.

Can the ecological perspective add something to healthcare and to the clinical encounter? We think so. Up until now the biomedical model has been dominant in medicine, but with a limited understanding of biology, taken from molecular biology, biochemistry and physiology. Although this knowledge is necessary for clinical work, we urge that it not sufficient for it. Dispositionalism suggests that medicine would benefit from an ecological turn. Such a turn toward an ecological perspective in medicine would place much more emphasis on understanding human biology as genuinely interactive, and on investigating how biological processes are integrated with human context and lived experience. In the words of osteopath Stephen Tyreman:

> Understanding what person-centred means is much more complex and multi-factorial than I once assumed. It is not merely a question of considering a person's individual needs and concerns and putting them first. It is recognising that human beings face up to the challenge of illness, pain and disability differently from how we might understand and seek to correct a fault in a car, say. (Tyreman 2018: 2)

5.4.3 Practice Is Motivated by Ontological Bias

We have presented two views on complexity: mereological composition and genuine complexity or emergence. Mereological composition was illustrated by the Lego bricks, where the parts combine to compose different wholes, but without any change to the parts themselves. Genuine complexity was the holist alternative, where the whole is an emergent existence in which the parts interact and change each other. The whole then has properties that are different from the composition of the properties of its parts. How does our ontological assumption about complexity affect scientific and medical practice? We can show this by applying the two philosophical perspectives to human pathogenesis.

Consider an autoimmune disease that might have biological causes (e.g. genetic predisposition) as well as psychosocial causes (e.g. lifestyle or emotional stress). Under the assumption that complexity is compositional mereology, the intertwining of different types of causes would represent a challenge to understanding causality. This is why fragmentation of different causal contributions, and their evaluation in isolation, is a well-established norm for scientific inquiry into causality. Genetic predisposition, for instance, might be tested by genotyping of patient groups, or by looking at the susceptibility of a lab animal strain with the genetic mutation(s) we want to test. The causal role of emotional stress might then be investigated through case studies, cohort studies, or other types of clinical studies. In the end, the results from different studies can be added together to give us the causally complex result.

This way of thinking about the scientific approach in medical research also influences medical practice, when dealing with complex medical conditions. Current medical practice aims to combine biological causes with psychosocial causes of illness. But also here complexity seems to be understood and handled according to the biomedical orthodoxy.

ONTOLOGICAL BIAS
Complexity is mereological composition of changeless parts.
⇓
NORM
The investigation into causal complexity starts with separation and isolation of each component.
⇓
PRACTICE
Fragmentation of causes into separate biological, psychological and social spheres is the starting-point for medical inquiry into complex conditions.

The introduction of person centered healthcare was partly motivated by the anti-dualist and anti-reductionist view that health and illness must be understood as belonging to the person, not to one or more bodily part. From this perspective, the mereological composition view is a simplification of the human condition. Such simplification might at times be useful in some contexts, but it can be dangerous, too. In the words of Marie Lindquist, director of the WHO collaborating Uppsala Monitoring Centre for International Drug Monitoring:

> Our ability to quickly categorise things around us is a basic instinct, a survival mechanism, and it was essential in a time when the ability to quickly identify danger was a matter of life or death. By classifying and grouping things, we make a complex reality more manageable. The problem is if we categorise in a way that is confining and excluding, and reduces reality too much – a simplistic reductionist approach easily leads to stereotyping, which can be anything from irritating to seriously damaging. (Lindquist 2018: 2)

Dispositionalism replaces mereological composition with emergence, which we take to be a type of genuine complexity. Genuine complexity is a result, not only of the composition of different parts, but also of their mutual interactions. For instance, the outcome of organ transplantation depends on how well the new organ interacts with the rest of the body. By focusing on such causal interactions, we also need to replace the epistemic norm for how to deal with causal complexity, scientifically and in medical practice.

ONTOLOGICAL BIAS
Complexity is genuine and emergent.
⇓
NORM
The investigation of causal complexity starts with observing the whole, and the interaction of different elements as parts of that whole.
⇓
PRACTICE
Whole person centred practice and patient narratives are the starting-point for medical inquiry into complex conditions.

We see, then, that it makes a difference both to scientific norms and practices how we understand complexity, ontologically. Ontology thus influences the norms and practices that define a scientific discipline. By questioning the philosophical biases of our methods and practices, one can also challenge what counts as scientific practice.

5.5 We Need an Ecological Turn in Medicine and Healthcare

We have argued that, once we acknowledge a phenomenon as genuinely complex, we also need to make some epistemological commitments for how to study that phenomenon scientifically. The most important is the fact that, if we aim to understand (and heal) living beings, we need to start by understanding complex *interactions*. This is not to deny the obvious: we all consist of parts (a liver, a heart, a brain, and so on), and there is much general and indispensable knowledge to gain about organs, tissues and cells by observing their behaviour in experimental and isolated contexts. The tricky part comes when we need to make use of such knowledge for the treatment of the whole person. In that case, it is necessary to keep in mind that although whole persons consist of parts, the identity of such parts is defined by their *interactions*: not only their interactions with the rest of the body, but also with the person's context, her history and her lived experience.

Not many would disagree with this, we think, when asked to reflect upon it. Denying it would be like comparing the human body to a machine, in which single parts interact without ever changing as a result of such interaction. This would entail that human life could be disassembled into its parts, and then re-created by re-assembling them. An absurdity, we might say. Yet, current practice and thinking in the medical profession tend to drift toward the mereological, or mechanical, simplification of human biology. Talking about a 'heart condition', 'irritable bowel' or 'skin disease' has a practical function, but in the long run it does make us think of illness as belonging primarily to a part of the body. As a consequence of this, we might come to think of illness as something that is curable by treating that part alone. In the clinical reality this becomes highly problematic. Here, co- and multi-morbidity are the rule rather than the exception, and most if not all medical conditions are at least partly caused by contextual factors. Patients with complex conditions will then have to be treated by different specialists for different health complaints, and the full picture is often lost.

> While co- and multi-morbidity is the norm in medicine, clinical guidelines are for individual illnesses. The 'guidelines mentality' often results in a situation that has been referred to as *silo medicine*… where each diagnosis has its own expert groups, patient organisations, industry sponsors and clinical guidelines. Diseases are then treated as wholes ("disease holism"), while patients are treated as composed of parts ("patient compositionality"). (Anjum 2016: 423)

What do we need, then, in more practical terms? How can we move toward an ecological turn in medical care: that is, one that understands health and illness by starting from interactions both with the physical and with the psycho-social? One important step is suggested by Getz et al. (2011) in their paper 'The human biology – saturated with experience'. Here they argue that the medical profession must acknowledge lived experience, meaning, and interpretation as not just 'side information' about the patient and her preferences, but as actually and physically influencing human biology.

> Long-term overtaxation of the physiological adaptability of human beings may lead to health impairment. This phenomenon, called «allostatic overload»…, is a consequence of physiological «wear and tear» due to strong and/or persistent threats to an individual's existence or integrity (the word encompasses both mental and physical aspects). The human body's reaction to stressors, which in our culture can be classified as physical (e.g. undernourishment, overfeeding, malnutrition, pollution, lack of sleep, lack of exercise, infections, noise) prove to converge at the same biological «level» as stressors we would classify as psychosocial (e.g. a life characterised by threats, neglect, abuse, poverty or overwhelming caregiving burdens): Both categories of stress can contribute over time to the development of autonomic dysfunction, changes in the immune system, chronic low-grade inflammation, endocrine disruptions and accelerated cell aging, measured as telomere shortening… (Getz et al. 2011: 684)

Accordingly, if we understand human biology from an ecological perspective, we cannot treat health or illness solely as the results of internal physiological or biochemical processes. Instead we should look for internal as well as external and contextual causes that might influence a person's health in a positive or negative way. For health, all levels of nature are united within one single patient: physiological, biological, psychological and social. All these levels affect and are affected by health and illness. Ecologically, we should also expect that these different influences will interact in nonlinear ways, and that what happens in one context cannot automatically be transferred to another context. Consequently, human biology cannot be understood without including, and even starting from, the higher level of complexity, in a top-down way.

From this ecological perspective, we might ask how efficient it is for medicine to be organised into separate specialisms, each with their own clinical guidelines (see Copeland, Chap. 6, this book for a more detailed discussion of guidelines).

5.5.1 Whole Person Healthcare in Practice

Immunologist and psychotherapist Brian Broom started a multidisciplinary centre in New Zealand in 1987 to offer what he calls whole person healthcare. The idea is to understand health and illness in a way that genuinely overcomes both reductionism and dualism, emphasising the link between life experiences and physical illness. The main goal is that patients, once they feel met as a whole and not as the sum of biological parts, will start to explore their own illness in a whole-istic way, in light of their lived experience. Broom and his team use patient stories, together with the medical perspective, as an essential tool to understand and treat chronic illness. This is how he describes his practice.

> Asking for a story may seem a simple matter but the implications are hugely important. And, in listening to a story, imagination is important… An example: A clinician asks a patient for her 'story', about what happened in her life when her symptoms started many years ago when she was 18 years old. This question is actually asked because the clinician assumes to some degree that the patient is a unitive whole, **and** that the patient's life experience (at 18) may be very relevant, **and** that opening this up may help the person get well in some way. Simply asking the question rests on really serious foundations. For me it entails

> the conviction that mind and body co-emerge together from the beginning of life, **and** therefore it is natural to imagine the story being part of the illness. It follows that there may be therapeutic potential in knowing the story. This is the paradigm of whole person care. The paradigm allows the clinician to imagine 'something' important in the story around age 18, and to ask the simple question.
>
> Brian Broom, 'Imagination and its Companions', CauseHealth blog (https://causehealth-blog.wordpress.com/2017/07/03)

Since biological conditions are part of meaningful humans, they are also meaningful. Broom talks about 'meaning-full disease', and his books collect many astonishing examples of the identity between mind and body, which he calls 'mindbody'. The whole person website offers numerous resources, including a tool called 'illness explorer', in a version for patients and one for practitioners. This tool is meant to guide the understanding of the disease as meaningful, and of meaning as embodied (https://wholeperson.healthcare). In Chap. 14 of this book, Brian Broom gives a detailed historical account and description of his practice.

5.6 To Sum Up…

We have seen that the biomedical model of illness relies on a dualistic and reductionist view of the human condition. Although intuitive and attractive for medical research and especially for some types of pathologies, this perspective has nevertheless been criticised for almost a century. The problem is that the biomedical model fails to see illness as a matter of the whole person, in that it overlooks the importance of social, lifestyle and psychological factors in the onset of complex and chronic disorders. Despite decades of criticism of the biomedical model, the current state of the art suggests that it is still predominant in medicine. Proposed alternative views, such as the bio-psychosocial model, still convey a fragmented perspective on human biology, and consequently a fragmented medical care. To face this problem, we propose a re-discussion of the foundational concept of *complexity*. While this concept is widely used, its meaning and interpretation usually remain implicit. Although complexity and emergence have become important words in medicine and clinics, we think that there is not enough reflection on what they really mean.

In this chapter, we have shown that a mereological view of complexity, in which complexity is seen as composition of multiple parts, motivates an investigation that starts from the separation of causal factors, and their investigation in isolation. In contrast, we propose what we call 'genuine complexity', in which the parts of a whole not only compose and interact, but also change each other through such interaction. This, however, requires that we start an investigation from the higher level of complexity: by observing the whole. At such a level, indeed, it is possible to focus

on interactions between context, lived experience and physical body parts. Several clinicians, globally, are pushing for a change in this direction. An ecological shift in medicine, we argued, will be not only necessary, but also unavoidable, if we acknowledge that human biology is *genuinely* complex and we truly reflect on the meaning and implications of this.

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