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A Living Systems Perspective on Health

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Abstract

Absence of a theoretical basis for defining health has made it an elusive concept and problematic to measure. This deficiency has precluded a clear delineation of the content of health science as a field. In this manuscript I use a living systems theoretical perspective to distinguish the parts and emergent properties of health. I term the parts of health, “assets,” which include the dimensions of energetics, restoration, mind, reproduction, and capabilities. Health assets interact at the level of the whole person to form integrated and emergent capacities that enable adaptation to environmental challenges, satisfaction of needs, attainment of life goals, and survival. Healthy individuals live long and adapt to and thrive within their environments. As more is learned about the interrelationships among health assets, their influences, their consequences, and how they interact to produce integrated functional capacities, a theoretically grounded and empirically informed ontology of health will emerge.

Keywords

health; living systems theory; energetics; restoration; adaptation; mind; capabilities; reproduction; well-being

Health is an elusive concept, difficult to define and problematic to measure. Linguistic analysis demonstrates that health has multiple semantic meanings from feeling good and whole to having high quality personal relationships and an optimistic future (Mordacci & Sobel, 1998). Today, few would suggest that health and absence of disease are synonymous. Nonetheless, the science of health is conventionally equated with the study of prevention and treatment of disease, disorder, and disability. Although numerous definitions of health have been developed (Blaxter, 2010), none clearly specifies the components that comprise human health. This lack of specificity regarding what health is in specific terms has been an important barrier to the development of a scientifically generalizable conceptualization.

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A theoretically grounded conceptualization of health should define what it is, provide a framework for its measurement, and form the basis of a classification system for new knowledge that is accrued across studies. To meet these challenges, this manuscript reviews and critiques extant conceptualizations of health to elucidate common motifs that form the foundation of what science means by health. This analysis is followed by a new proposal that uses a living systems theoretical perspective to distinguish and define the construct of health. I start with the assumption that health enables and promotes our capacity to thrive and survive within our physical and social environments. To know what health is requires an understanding of those assets that imbue individuals with life and bring forth our livingness. These health assets interact to enable at the level of the individual the capacity to adapt to the environment, satisfy one's needs, attain desirable goals, and lead long and productive lives.

It is important to note that the theoretical discussion in this manuscript does not specify a full model of health, which would also address how health changes over the life course, how it is shaped by dynamic interactions between an organism and its environment, and the consequences of good and bad health for outcomes. The discussion is restricted to the theoretical basis for conceptualizing what health is, a necessary starting point for a comprehensive theoretical model.

The field of health science lacks a theoretical basis for defining health. This gap has precluded clear delineation of the content of the field, hampered the measurement of health, and thwarted coherent organization of knowledge regarding the production, development, and consequences of health. For example, the National Institutes of Health (NIH) defines its mission as seeking “fundamental knowledge about the nature and behavior of living systems,” (National Institutes of Health) yet it organizes research in terms of diseases and mental disorders, and provides no definition of health to guide research.

Health as Well-Being

In 1946 the World Health Organization (WHO) defined health as a: “state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity” (World Health Organization, 1946). By rejecting the biomedical view of health as absence-of-disease, this definition was a major advance in specifying what health may be, rather than merely saying what it is not. On the other hand, the definition conflates health with happiness and life satisfaction, key dimensions of well-being (Awofeso, 2006; Saracci, 1997; Wachholtz & Sambamoorthi, 2011). Healthcare practitioners have been concerned about using this definition as a basis for delineating the scope of medicine, because it implies a broad set of phenomena well beyond the boundaries of conventional healthcare (Huber, Knottnerus, Green, van der Horst, Jadad, Kromhout et al., 2011; Schramme, 2007). The requirement of ‘complete well-being’ is not only utopian, it means that virtually no one can be healthy (Huber et al., 2011). Moreover, the definition is a static view of human health and is difficult to operationalize because well-being is normative and individually determined.

Species-Typical Functioning

An objective, empirical notion of health was championed by Boorse (1975, 1976, 1977), Lennox (1995) and Daniels (1985, 2007) who argued that health is species-typical functioning that enables attainment of the evolutionarily determined goals of reproduction and survival. This view of health is purportedly value-free and was intended to form a theoretical basis for medicine. An objective scale that operationalizes species-typical functioning has appeal for policy purposes, because it enables allocation of health resources according to a universal definition of need (Daniels, 1985). However, assessing species-

typical functioning depends on a society's historical and geopolitical context and evaluates health in purely biological terms (Weinstock, 2011). Three hundred years ago high rates of child mortality for humans was 'species-typical,' which today is not the case, at least in developed nations. Although species-typical functioning divorces the organism from its environment, normality in one environment may be abnormal in another. In areas where malaria is endemic, sickle cell trait confers a survival advantage, but in high altitude regions its presence threatens health with physical exertion.

Instrumental Value of Health

In response to the theory of species-typical functioning, others proposed that health cannot be defined merely by evaluating an organism's biology, but should be seen as enabling attainment of desired outcomes. Lennart Nordenfelt's (1993) holistic theory of health promoted a subjectively determined conceptualization of health, defining health as "the ability, given standard circumstances [for an individual] to realize his or her vital goals." A distinguishing attribute of this definition is its instrumental notion of health. Nordenfelt (1995) suggested that health enables vital goal attainment, which he defined as those goals that produce a minimal degree of happiness. The holistic theory provides a concept of health as prior to and an influence on well-being. To determine whether an individual's vital goals are being met requires that an examiner elicit these from each individual. Measurement is therefore difficult to implement, because different standards must be applied across individuals and cultures (Schramme, 2007).

In 1986 the first International Conference on Health Promotion was held in Ottawa, Canada. The conference produced a new definition of health, similar in spirit to Nordenfelt's holistic theory, as biopsychosocial resources that help individuals realize their aspirations and fulfill their needs in everyday life (Charter, 1986). This definition expresses a common motif regarding health's instrumental value, that health is a means to an end and a means for fulfilling goals, but not the objective of life. A key problem with the definition is that there is no specification of the resources that constitute health. Indeed, what constitutes everyday life varies by age, time, and place and aspirations vary across individuals (Williamson & Carr, 2009). Measurement of health can differ across these dimensions too. The definition, therefore, should be considered more aspirational than operational.

Developmental and Systems Perspectives

The Institute of Medicine's (IOM) Committee on Evaluation of Children's Health in 2004 produced a definition that accounted for the dynamic development of health across the lifespan. They wrote that health is: "the extent to which individual children or groups of children are able or enabled to: a) develop and realize their potential; b) satisfy their needs; and c) develop the capacities that allow them to interact successfully with their biological, physical, and social environments"(National Research Council and Institute of Medicine, 2004). This definition also emphasized the instrumental value of health, while adding a developmental perspective (Stein, Stanton, & Starfield, 2005) The IOM definition explicitly incorporated a systems view of health resulting from dynamic interactions between individuals and their contexts. What gets classified as a biological influence versus part of health itself is uncertain, because an individual's biology is considered both an influence on and part of health. There is no theory to help distinguish the two. The definition does not elaborate the specific components of health, nor ground the conceptualization in a theory that bounds its scope. Nonetheless, the addition of a developmental and systems view on the production of health was an advance over prior conceptualizations.

Health as Adaptation

Some theorists assert that it is more correct biologically to define health as how well an organism adapts to its environment rather than species-typical functioning, because an organism can never be isolated from its surroundings. George Engel (1962) suggested that health is: “when an organism is successfully adjusting in its environment and is able to maintain this state free of undue excitation, capable of growth, development and activity in an integrated and effective sense.” This view was echoed by Wylie (1970), Dubos (1959, 1965, 1968), Selye (1978), and Antonovsky (1979). According to an adaptation view, health is effective functioning within an environment, and disease results from failure of adaptation (Lancet Editors, 2009). A limitation of this perspective is that the concept of adaptation is reactive, because it denotes response to challenge. However, health is more than a reactive concept, it promotes growth, development, and thriving. Although adaptation is necessary for these other goals, it is not sufficient. Other attributes of health need to be invoked to create a more complete definition.

Summary of Prior Conceptualizations

The definitions of health presented above have some common attributes. Health is generally seen as having instrumental value, but the goals that health enables are variously defined as biologically or individually determined. A common gap in all conceptualizations is that they do not specify the assets, in other words the component parts, that health comprises, nor the integrated functions that these components interact to produce. The breadth of the context in which an individual's health is viewed also differs (Smith, 1981). Does health exist entirely ‘within the skin’ or does it include the dynamic interactions with the environment? There appears to be a consensus that environmental factors are critical to health, although conceptualizations differ with regard to whether these factors are influencers or actual components of health. Some models, such as species-typical functioning, divorce assessment of health from the environment, whereas others require an evaluation of an individual's interactions with the environment as a fundamental consideration of healthiness.

Living Systems Theory

Living beings are open systems (von Bertalanffy, 1950) which dynamically interact with their environments (Lazlo, 1996; Miller, 1978) to maintain energy flows necessary to reduce internal entropy (Capra, 1996; Lovelock, 1979; Miller, 1978) and to develop the complexity required to support system functions (Kirkwood, 2005; Margulis & Sagan, 1995; Miller, 1978). Ilya Prigogine (1984, 1989) used the term ‘dissipative system’ to describe a type of open system that extracts useful energy from the environment to support metabolic functions required for such purposes as movement, growth, reproduction, and increasing internal complexity, while dissipating less useful forms of energy to the environment. As dissipative systems, organisms manage energy flows to ensure that the organization of internal sub-components is imposed by the living system itself rather than by the environment. This self-organization is essential for living beings to function autonomously.

A living system is arranged hierarchically. Each system level interacts with its parts to produce emergent properties such as complex behavior (Holland, 1995; Lewin, 1999; Weiss, 1973). Multiple levels of organization for living systems are possible, from the cell (the basic building block) to supranational organizations (Miller, 1978). Each level is characterized by sub-systems that process energy, information, or both, as well as emergent, system-level properties that result from the interactions of the sub-systems. Thus, if health is an attribute of individuals, living systems theory suggests that it has both component parts, emergent properties that result from the dynamic interactions of these parts, and environmental influences.

A living system is an autonomous unity (Maturana & Varela, 1992) that is a self-making network continually producing itself (Margulis & Sagan, 1995) such that all components are created by other components within the network. The human body replaces 98% of its atoms every year while maintaining its unique pattern (Smithsonian Institution Board of Regents, 1953). This self-making is an essential feature of life, a process called autopoiesis (Maturana & Varela, 1980). Autopoiesis preserves the pattern of the whole, its identity, as each part is regenerated over time (Rappaport, 1986). Because autopoiesis is possible in both living and non-living systems (Bourgine & Stewart, 2004), it is a necessary but not a sufficient condition for life (Bitbol & Luisi, 2004; Bourguine & Stewart, 2004). The biological notion of autopoiesis of living systems is highly related to the concept of adaptation, which is the capacity of an individual to maintain self while overcoming environmental challenges and returning to a prior or new equilibrium state.

Not only are living systems autopoietic, they are also cognitive entities. They have mind, which in general terms comprises mechanisms for sensing environmental data, transforming those data into information by interpreting what they mean, formulating thoughts and actions in response to this new information, and learning from experience (Bateson, 1979; Maturana & Varela, 1980) thereby generating knowledge.

Living systems are in continuous interaction with their environment, exchanging both matter-energy and information. Internal stability is maintained because of organizational distinctness (Bitbol & Luisi, 2004) and the capacities of the system to restore balance and equilibrium. Living systems employ a multitude of control mechanisms to regulate system variability (Lipsitz & Goldberger, 1992). The degree of biological variability that results from the dynamic interactions of physiological systems is reflective of an organism's capacity to respond and adapt to the environment (Sigerist, 1960). Significant variability within established parameters is adaptive. Evolution has selected for negative and positive feedback loops that not only enable regulation of a given state or function, but also permit self-transcendence, adaptive jumps to new forms of self-organization, that occur with learning and development of new knowledge and skills.

Health Assets

According to living systems theory, the health of an individual is composed of both parts, or sub-systems, and emergent, integrated properties of the self-system. Living systems have a range of health assets to manage energy and information flows, restore balance resulting from system perturbations, perpetuate the species, and develop skills to support increasingly complex responses to environmental stimuli. These assets, the components of health, can be organized along five dimensions: energetics, restoration, mind, reproduction, and capabilities (see the Table).

Health assets are derived from living systems theory and conceptualized as specific, measurable attributes. Each asset depends on the integration of manifold molecular, tissue, and organ system structures and processes. For example, an individual's lung function is a health asset domain within the energetics dimension. Adequate lung function depends on manifold ventilation and respiration functions at tissue, cellular, and sub-cellular levels.

One way to think about health is that it comprises an individual's "operating system." The body can be thought of as the hardware, and survival, needs satisfaction, attainment of goals, and adaptation are the applications. The applications are based on a number of sub-routines, the health assets, which interact with one another to ensure effective operation of the system. Unlike a computer system, though, living beings are cognitive systems that learn from their experiences. It is not enough to merely manage energy flows, for example. Individuals also require the capacity to experience energy flows and learn from those experiences. For

example, the experience of hunger is necessary to not only satisfy the need for sustenance but also to learn which actions are most effective at alleviating this need. The experience of health, therefore, enables individuals to make meaning of their past and learn.

Energetics

Living systems use energy to create, maintain, and restore internal self-organization and support behavior in the environment. The energetics dimension is the set of functions and experiences involved in managing an individual's energy. Specific energetic health assets include the capacity to maintain and manage water, electrolytes, nutrients, and gas flows, and the ability to regulate overall energy balance. The efficiency with which these energy management processes are carried out in response to environmental demands describes a person's physical fitness.

Restoration

Humans are continuously bombarded with environmental insults and even damage to our somatic structures. Exposure to sunlight, stress, pathogens, chemicals, and other environmental factors continuously challenge us to maintain health. Living systems have developed a number of mechanisms for restoring an individual to a baseline or new equilibrium following one of these perturbations. These processes comprise the restoration dimension of health. Restorative capacities prevent the occurrence of a perturbation, such as when the immune system inactivates a pathogen before it causes illness; they renew vitality, which occurs with an activity like sleep; and, they regenerate damage when it occurs, which is what happens with wound healing.

Reproduction

Although a living system need not reproduce in order to be considered alive, life would cease to exist without some capacity to sustain the species as well as to adapt to environmental changes that occur over long intervals. If autopoiesis is self-making of a single living being, reproduction, another health asset dimension, is species-making for living beings. Indeed, the capacity of two organisms to reproduce with one another is a distinguishing characteristic of a species. For humans, our sexuality is an integral part of the reproduction dimension. Health need not be limited to reproductive capacity. Healthfulness can also be found in our capacity to pursue sexually oriented needs and goals.

Mind

Organisms have developed the capacity to receive, process, and interpret data from the internal and external environments to create information that can be stored as memories and used to formulate options for action plans. Mind is the health asset dimension that subsumes these information management processes. Mind is the process of knowing and is essential for all living systems to function effectively (Bitbol & Luisi, 2004; Bourguine & Stewart, 2004; Capra, 1996; H. Maturana & Varela, 1980). An organism would rapidly perish if it were unable to perceive and read its environment, know what environmental information means, act in ways that appropriately respond to this information, and learn from its past. Mind assets provide the ability to sense data in the environment (e.g., sensory systems such as vision, hearing, etc.), sense our emotions, perceive the meaning of sensory and emotional data to create information that can be interpreted by an individual, and with accumulated experience, knowledge accrues as we learn from repeated exposure to the same type of information. Repeated exposure to a painful experience should lead to avoidance of that experience, because of the noxious effects of pain. Mind assets serve to organize our thoughts and actions, 'executive function,' and motivate us to take action.

Capabilities

The instrumental value of health is that it provides resources for an individual to engage in and experience life (Anand, Peter, & Sen, 2006). The capability dimension of health assets includes domains that enable individuals to move around, communicate with others, care for oneself, and interact in social situations. These are the components of complex behaviors that permit a person to pursue various “doings” and “beings” (Sen, 1993, 1999). The specific beings and doings that an individual chooses to pursue will be related to a variety of historical, cultural, political, and economic contexts. Capabilities and the other health assets, however, provide the means by which these doings and beings can be pursued. Better health broadens our opportunity set, widening the options we can select in our pursuit of happiness. Achievement of those doings and beings we choose to pursue is an important determinant of well-being (Sen, 1993, 1999). Thus, well-being results from health, which stands in contradistinction to the WHO definition that equates health with well-being.

Definition of Health

Health comprises resources for achieving goals, satisfying needs, adapting to the environment, and surviving. It is not the end-result of life, but a means by which desirable outcomes, what Amartya Sen called doings and beings (Sen, 1993, 1999), can be pursued. In other words, health has instrumental value (Abanobi, 1986; Charter, 1986; National Research Council and Institute of Medicine, 2004; L Nordenfelt, 1993; Lennart Nordenfelt, 2007; L. Y. Nordenfelt, 1995; Richman, 2005; Seedhouse, 2001). The adaptability dimension of this perspective on health is consonant with other conceptualizations of health (Bircher, 2005; Dubos, 1959, 1965, 1968; Huber et al., 2011; Lancet Editors, 2009), but extends this perspective by suggesting that health facilitates personal growth and development, thriving, and living a long life.

Based on this living systems analysis, a new definition of health is proposed:

Health enables individuals to adapt to their physical and social environments, satisfy their needs, attain their goals, and live long lives.

An individual's overall health emerges from the patterning of interactions of the health assets of energetics, restoration, mind, reproduction, and capabilities, which interact with one another to produce the functional capacities (i.e., the ability to perform) of adaptation, needs satisfaction, goal attainment, and survival (Figure). Health develops over the life course as a result of dynamic, non-linear interactions between individuals and their environments.

Adaptation

Adaptation is a core attribute of an individual's health. It is important to note, however, that adaptation is a complex phenomenon that can occur on different time scales, from integrated mind-body responses of allostasis (McEwen, 1998; McEwen & Wingfield, 2003) to adaptive plasticity in which organisms modify the regulation of biological pathways through epigenetic and other environmentally induced cellular changes (Gluckman, Hanson, Bateson, Beedle, Law, Bhutta et al., 2009; Holland, 1995). Over generations, adaptation occurs via reproduction, evolution, and natural selection of phenotype that optimizes the likelihood that an organism will pass on its genes.

Adaptive capacities are distinguished from restorative functions, which are organized as health assets, in that the former occurs when multiple health assets interact to produce an integrated and emergent response of the whole individual to a given challenge. Restoration includes specific functions like immune response, wound healing, and sleeping. Adaptation

must be measured by probing an individual's capacity to respond to and sense the reaction, whereas restorative assets lend themselves to direct interrogation.

Empirical Evaluations of the New Formulation

By clearly defining what health is, the proposed formulation of health not only gets us closer to realizing Antonovsky's vision of a science of salutogenesis, the distribution, determinants, and consequence of health (Antonovsky, 1979, 1985, 1993), it also serves as a framework for testing, refining, and formulating hypotheses about health. The theoretical construct I propose has functional and experiential components, which is consistent with Richman's concept of embedded instrumentalism (health qua organism and health qua person) (Richman, 2004, 2005).

The intent and values of humans as moral agents are irrelevant to the assessment of health. The achievement of a meaningful life for humans is not only influenced by their health but also determined by their choice of which goals to pursue. These choices are highly individualistic, reflecting one's morals, culture, preferences, desires, and time.

The strength of this new formulation of health will be determined by how useful it is in guiding measurement and predicting the relationship between individual's health status and their (1) well-being, (2) actual needs satisfaction, (3) achievement of desired goals, (4) freedom from disease, and (5) length of productive lives. Healthier people should achieve higher states of happiness, life purpose, and achievement, while being relatively free from disease and threats to survival.

Conclusion

The conceptualization of health presented in this manuscript can be refined by dividing the five health asset dimensions into measurable domains that are more granular and conceptually coherent. As these domains are established and measures are attached to them (e.g., sleep function as domain and Actigraphy, polysomnography, or self-reported sleep quality as measures), we can build a health measurement typology that should be useful for research and eventually clinical practice. As more is learned about the interrelationships among health assets, their influences, their consequences, and how they interact to produce integrated functional capacities, a theoretically grounded and empirically informed ontology of health will emerge.

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Figure 1.
Health Comprises Component Parts, Assets, and Integrated Capacities

Table

Health Asset Dimensions.

Dimension	Definition	Theoretical Basis
Energetics	Managing energy to maintain self-organization, enable self-transcendence, and support the energetic requirements of essential functions of a living system.	Living beings are dissipative systems that continuously exchange energy with the environment to support system functions, such as growth, maintenance, reproduction, and action.
Restoration	Maintaining the integrity of self via a set of processes that prevent, overcome, and heal damage from system perturbations inflicted by the internal and external milieus.	Continuous interaction with the environment requires that living systems prevent, withstand, and repair damage from environmental challenges that threaten the integrity and development of self.
Mind	The capacity to sense, interpret, and act on data available from the parts of the whole (i.e., organs, tissues, and cells) and the environment, and learn from those experiences.	Living systems process information from their internal and external environments in order to formulate action plans, learn, and experience life.
Reproduction	Creation of offspring.	To sustain the species, living systems reproduce.
Capabilities	Functional capacities that enable an organism to execute tasks, engage in activities, and, for social beings, interact with others and the social environment.	Depending on stage of development, living systems have functional capacities that enable action related to satisfaction of needs and attainment of goals.