

The Unified Theory of Meaning Emergence

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Introduction

Nursing science and theory is unique among the scientific disciplines with its emphasis on the human-environment relationship since the time of Florence Nightingale. An excellent review article in the Jan-Mar 2019 issue of *Advances in Nursing Science*, explores the range of nursing thought and theory from metaparadigms and grand theories to middle range theories and identifies a common theme. A Unitary Transformative Person-Environment-Health process is both the knowledge and the art of nursing. This type of conceptual framework is both compatible with and informed by complexity science and this theory restates the Human-Environment in a complexity science framework.

This theory makes a two-fold contribution to the science of nursing and health, the first is in the consolidation and restatement of already successful applications of complexity theory to demonstrate commonalities in adaptive principles in all systems through a unified definition of process. Having a unified theoretical platform allows the application of the common process to extend current understanding and potentially open whole new areas for exploration and intervention. Secondly, the theory makes a significant contribution in tying together the mathematical and conceptual frameworks of complexity when most of the literature on complexity in health separate them (Krakauer, J., 2017). In this theory, both mathematics and natural language are legitimate descriptors of phenomenon subject to scientific inquiry. At the same time this theory limits itself to complexity concepts that can be strongly connected to underlying mathematical principles.

Complexity and health: What is known

It is in the description of disease where complexity science is the most robust in terms of experimental evidence. It has been well established that diseases from diabetes to cancer to Alzheimer's and even the aging process itself can be characterized as a loss of behavioral complexity that can be quantified through the mathematics of complexity Lipsitz, L. (1992), Churrua, J. (2008), Wang, B. (2017). Put simply, the loss of complexity that leads to disease is a loss of communication, in that, a part or a process of the body is no longer sharing information with another part of the body. This loss of communication between body systems is such that one system's behavior becomes largely independent of information input from other systems which prevents effective adaptation.

Bolstering the insight that comes from viewing disease as a breakdown in communication and adaptability is the appearance of the recurring theme of efficiency of action in life systems where it appears life has ways of exerting the least amount of energy to get the most in return. All CASs are faced with two basic obstacles which are that there is too much to know and the information is changing all of the time. There is an unavoidable tradeoff between the amount of environmental information that can be gathered within a period of time and the ongoing relevance of that information Banerjee, K., (2017). The goal then is to minimize of the amount of error between what you anticipate as the future state of the environment and what the actual state of the environment is as it becomes manifest. The solution to this problem of prediction is to gather the most relevant information while also actively ignoring what is not important and doing all of this in the shortest possible time. Because a nonlinear system is not completely random and so has some limited predictability, information patterns can be detected and from these patterns models of prediction can be developed and subsequently refined with additional experience.

Living systems as complex adaptive systems, are able to make predictions based upon information gathered from internal and external environments. This information is gathered through the sensory mechanisms available to the complex adaptive system at the scale of the hierarchy it occupies. The type of environmental sensing possible at each level of a living system differs both because of what a complex adaptive system is capable of sensing and the type of environmental

information it is adapting to. The more accurate the prediction is about the future state of the environment the more efficient and successful the actions taken in the environment will be. The minimization of predictive error is the difference between the predicted state of the environment at a future point in time and the actual state as it becomes manifest.

A Unified Definition of Health

This theory of health and nursing attempts to bridge the gap between the mathematical and conceptual worlds to create a unified understanding of complexity and health.

While the complexity definition of health according to this theory is based on the mathematics of the minimization of predictive error it will be stated in paired quantitative and qualitative frames.

Definition of health in the quantitative frame: *“Health is the scale-free, continuous evolutionary process for the global minimization of predictive error”*. Definition of health in the qualitative frame: *“Health is the simultaneous, continuously dynamic and evolutionary search for the optimal predictive, behavioral solutions at all levels for the mutual benefit and continued existence of the whole system”*. For this definition of health, the human in the environment is a unity as the health of the human cannot be separated from the environment.

A Unified Process of Meaning Emergence

The Unified Theory of Meaning Emergence (UTME) states that there is a common process through which all systems minimize predictive error and therefore improve health and is referred to in this theory as meaning emergence. The process of meaning emergence reflected in the is derived from three key classes of mathematical principles that are postulated to be the minimal required in complex adaptive systems (CAS) at all scales for the effective minimization of predictive error and continuation of life. All CASs must have at a minimum a method of environmental sampling and pattern matching, a method of path selection and method of collaboration. Each of these methods of error minimization can only be truly effective when used together. Complexity science has developed a number of candidate formulas in each class, but I have chosen only one validated example in each class for the sake of simplicity. The three mathematical concepts are: Bayesian predictive process, biased random walk, and quorum sensing. While in each of these domains the names of the players and the informational interactions will differ; the theoretical conjecture is that the process for the minimization of predictive error is largely the same in all systems and can be understood with these three paired mathematical/conceptual principles.

Bayesian Predictive Process: environmental sampling and pattern matching

The Bayesian statistical process starts with a best guess prediction of some future state based on the accumulated knowledge of a system. The difference detected between the initial prediction and the actual outcome is the amount of predictive error. The dynamic nature of the environment makes a perfect prediction impossible so there will always be some level of predictive error. The amount and source of the error that is detected is used to adjust the probabilities within the Bayesian predictive model and increase the accuracy of future predictions. The predictive comparison is between the pattern detected in the environment and the representation of that pattern within the CAS Kiebel, S. (2008) Heeger D. (2017). The process of pattern matching of the Bayesian model will take on a variety of structural forms depending on the CAS. In proteins, such as immunoglobulins, the representative pattern/memory is held in the molecular shape while at the human social level it may be in shared words or memes Arganda, S. (2012). The Bayesian predictive model in any CAS serves as the source of bias for the biased random walk and guides the steps of the CAS along the walk to the minimization of predictive error and health.

Biased Random Walk: Path selection

A constantly changing environment provides an innumerable number of path choices for any CAS trying to find its way. The path that a CAS takes is not random but is based on the Bayesian bias that has been established by experience in the environment as to what would likely be the most successful choice among the many options. In the process of meaning emergence, each step on the path is envisioned as the result of a single Bayesian predictive cycle. In the UTME the steps on the path are divided into two types; one of external (environment) pattern matching called a “externalization” step and one of internal (CAS) pattern matching called a “internalization” step. This division into step types will hold true whether a step is a sensory prediction or an action prediction and across all spatiotemporal scales.

These patterns can be discovered through external pattern matching but are represented by a corresponding pattern in the internal environment of a CAS through a variety of representational forms.

Table 1

System	Level	External Pattern Matching	Internal Pattern Matching
DNA	Molecular	Repressed inactive	Activated
Bacterial	Cellular	Roll	Run
Brain	Organ	Attention Network	Default Network
Herd	Social organization	Search	Find

Quorum Sensing: Collaboration

Quorum sensing is the third source of prediction generation through which a collection of similar CASs creates a group prediction based on shared information. Because each CAS in a group occupies a different part of the environment and has a slightly different model of the environment, the sharing of individual predictions generates a collective super prediction that increases the overall predictive accuracy of individual group members. The group itself takes on the characteristics of a CAS as the collection of individual member CASs creates a series of predictions through the process of quorum sensing. The grouped CASs and the shared super prediction then operate as an environmental framework for individuals within that group must adapt to the super prediction in order to minimize their own predictive error. For humans, quorum sensing is the process through which words, memes and cultural traditions arise König, P. (2006).

Quorum sensing is also the process through which any CAS develops predictive hierarchies that generate meaning at multiple levels within the system. In this predictive hierarchy the prediction at the highest level of a system is not isolated but arises from the predictive processes emerging from lower levels. Consequently, every super prediction will contain predictive steps within predictive steps. For example, a consciousness step on a predictive path in the brain is derived from multiple shorter and more frequent steps that came before it Meunier, D., (2011) and Wacongne, C. (2011). Taken together these three mathematical/conceptual pairings, outline a unified process to maintain homeostasis in all complex adaptive systems through the minimization of predictive error.

Meaning emergence in infants, children and adolescents

The minimization of predictive error and the process of adaptation starts in the brain with it connecting with the body starting from the head down and then out to the extremities. This process of

meaning emergence and adaptation moving from the center out represents the extension of the Bayesian predictive process from the body, to the immediate set of care givers and then the human social environment. The stages of development outlined here closely follow the age ranges for developmental milestones in the work of Erik Erikson and Jean Piaget (Mooney, C 2000). These traditional developmental stages will be reinterpreted using the unified theory of meaning emergence process. There are seven basic stages in this theory of development from birth to adulthood and as with other theories of developmental staging, the age range for accomplishment will vary somewhat by individual. In this conceptualization of pre-adult growth and development, each stage of child development is viewed as process of path selection with each stage of development being a single step on that path. The steps on the path of development will consist of alternating externalization (external pattern matching) and internalization (internal pattern matching) steps consistent with a biased random walk. Table 2 below lists the stages with their age range and major developmental characteristics.

Table 2:

Name of developmental stage	Age range	Major accomplishments	Type of stage
Connecting to the source	Birth to 5 months	Identifying and developing beginning communications with major caregivers	Externalization stage
Naming the other	Six months to 18 months	Verbal identification of environment and relationships	Internalization stage
Naming the self	18 months to three years	First formation of self-identity including gender	Major internalization stage
The social self	Three years to six years	Basic social relations developed	Externalization stage
The competent self	Six years to 12 years	Independence, cultural and intellectual competence	Internalization stage
The communal self	13 years to 18 years	Developing peer social group	Externalization stage (possible major stage)
The adult self	19-26 years	The brain completes maturation and social roles adopted	Internalization stage

There are three basic developmental themes that are evidenced as a child progresses through each stage. First the process of incorporating more complex levels of understanding is Bayesian like with new information being built upon old information in a continuous improvement of the predictive process. Secondly, each stage is conceptually distinct from the previous and where the previous stage of predictive action is subsumed within the newly emerging stage. Lastly, this continuous improvement in predictive efficiency results in the emergence of a networked predictive hierarchy which is reflected in an increase in complexity and adaptive capacity specific to the social network the child inhabits. The separation between the stages reflects the distinctly different predictive modalities for sensing and acting in the world as the child develops.

Connecting to the source: Birth to 5 months

The development and emergence of the first stage of predictive optimization prior to initial self-concept formation is evident from birth to around five months of age and is termed connecting with the

source. This is an externalization step and is the first on the random walk for the child as they enter a largely unknown environment and must identify the most dominant patterns in that environment. This demonstrates the central role the environment plays for any CAS because it is the baby that has to adapt to the environment. The most important patterns established in this stage of development are bonding and connecting with caregivers. In this first stage infants not only bond with caregivers but also actively imitate the characteristics of the caregivers they have bonded with; language, facial and body movements, mood and other communication aspects are mimicked.

Naming the other: 6-18 months

The stage of meaning emergence just prior to self-concept formation, occurs from approximately 6 months of age to 18 months and is termed Naming the Other. In this internalization stage, the primary developmental task is to generate the internal predictive models to allow meaningful relationships with people and objects in the environment through the twin goals of identification and manipulation of those objects. The objects subject to this process of predictive improvement range from an exploration of the body itself to the environment in general. The accomplishment of the goal in this stage requires an extension of the predictive process embodiment into all parts of the body and into the surrounding environment. Self-feeding, rolling, crawling, a manipulation of toys to get the desired response and pointing to parts body are all new behaviors exhibited at this time. This is accomplished through a combination of motor and language tools. The infant also learns that they can manipulate their environment through the actions of others. Pointing to a desired toy or food in the presence of a caregiver will most often result in the accomplishment of obtaining the desired object.

In language development, sound patterns of the caregiver language identified in the previous stage, begin to be combined into words and by the end of this stage words are being used for shared meaning communication with caregivers. This is a highly significant achievement as almost the whole of human society is based on the effective manipulation of symbols even when there is a variety of symbols that represent the same physical object. A very common object that is identified early is that of a dog which the infant learns in this stage can be interchangeably represented by the word dog, the sound a dog makes or a picture of the animal. The socially shared ability to represent real objects through the use of symbols, allows those objects to be discussed even in their absence and enhance predictive success and represents the first step in coordinated social planning.

Naming the self: 18 months to 3 years

With the completion of the first two stages, the child for the first time is able turn their predictive modeling inward with self-awareness and conceive of itself as an individual identity; this stage is termed Naming the Self. This period of initial self-concept formation lasts from approximately 18 months to three years of age. The formation of the individual identity and self-awareness now allows a child to observe their thoughts and emotions and create additional information about those thoughts and emotions from the viewpoint of a self-aware person. This new self-concept is also projected onto objects such as a toy and when the object is threatened the self is threatened. In the UTME, this stage is identified as an internalization major stage because the emerging model of the self-concept is required for development of social standing and interaction.

The social self: 3-6 years

The establishment of a self-concept allows for a period of further emergence of complexity, which occurs between the ages of approximately 3-6 years and is termed the social self. This is an externalization stage and the development major task here is searching the social environment with the identification of major social roles and the development of a theory of mind. This is accomplished through a combination of real and play socialization by acting out adult roles. These adult roles may take the form of family members, adult professions or even inanimate objects. The stories that develop through play are often not strong on details and can take unexpected turns with the emphasis on the continuation of the story and often include fantasy such as talking animals or bugs. The creation of shared social stories between children at this stage is extremely valuable for setting the social skills that will be needed later in life.

The competent self: 6-12 years

This stage is a continuance of meaning emergence mediated through the self-concept, between the ages of six years to 12 years and is termed the Competent Self. This is an internalization stage where the child creates internal models reflective of the basic intellectual, cultural, social and religious competencies of the child's society. Importantly relationships develop with adults in the community other than parents who impart the required information for social functioning according to their area of expertise. This new learning is typically gained through socially sanctioned institutions such as schools, religious settings and cultural clubs. The learning gained is specific to the social environment and reflects the accumulated shared predictive bias of that society.

Language skills gained in this stage go well beyond a necessary expansion of vocabulary to the use of socially important stories that can be internalized by the child for effective functioning in that environment. These stories guide the child about how to think about the past, live in the present and anticipate the future. These shared stories are necessarily subject to the same selective predictive bias as any other method of prediction.

The communal self 13-18 years

Starting at 13 years of age the next stage of development termed the Communal Self, where the major accomplishment is peer group development. In this externalization stage, the adolescent has many of the basic skills that they will use as an adult and will explore the social environment for a peer group that fits their real or desired social group. The choice of social group will be heavily influenced by adult pressure and is often a source of intergenerational conflict.

In this externalization stage it is also a time where occasionally the young adult will explore spiritual learning and may first be able to transcend the self-concept. The ability to transcend the self-concept constitutes the second major stage. The predictive value of self-transcendence will be fully explained in the context of a model of self-identity in the next section.

This stage represents the complexity concept of critical edge as this group is prone to exploration of new ideas and the reevaluation of old ones. This is critical as predictive models must be continually updated or they will become less efficient as the environment changes. Language activities in this stage reflect this tendency for exploration symbols with new words specific to that generation with new musical and artistic tastes. Generation specific stories develop forming a time specific platform for social coordination and problem solving.

The adult self 19-26 years

The final stage is the development of the adult self-concept. This is an internalization stage as the child is now an adult establishes the beginnings of their life path with a combination of education for career, career and the possibility of starting their own families. The generational stories that developed during the adolescent years provide a foundation for a different approach to parenting which changes the development of subsequent generations.

Using this child development framework the dynamic interplay between the physical, mental and social systems allows the nurse to craft plans of care that bring all of the opportunities for development together and allow all children to reach their maximal level of adaptive capacity. What is recognized is that the emphasis in development comes first from providing the environmental context appropriate to the adaptation that is to occur. Secondly there is ample opportunity for enhancement of adaptive capacity through practice.

Meaning Emergence in Health Behavior

In this theory, the self-concept that individuals develop, is a Bayesian predictive model that is reflective of the natural process of adaptation to the social environment they live in. The

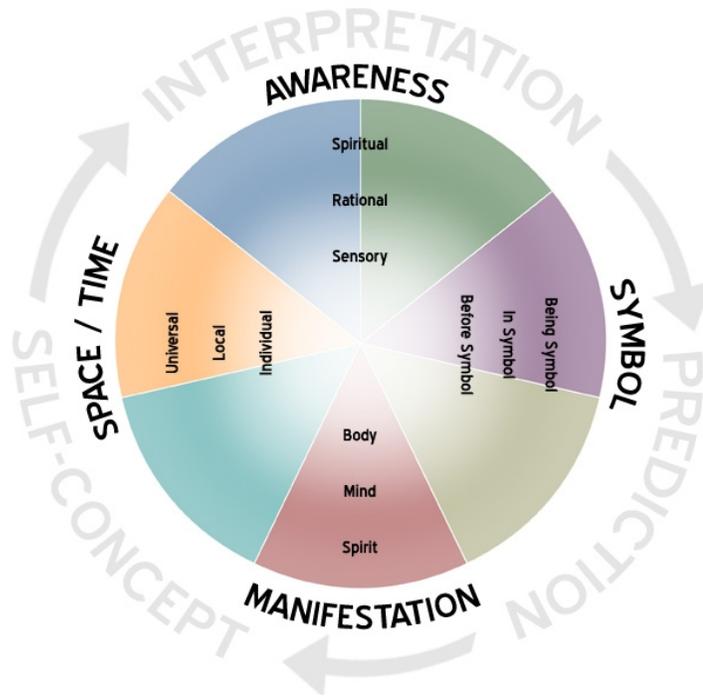
adaptation of individual habits to prevailing social habits, is not forced but occurs without our awareness through the process of quorum sensing. The consciousness each of us carry with us every day is only a narrow slice of the predictive hierarchy that combines predictions emerging from within our body (individual habits) and social predictions we see in our social environment (social habits). Most of these predictions do not reach our conscious mind but happen automatically based on what is appropriate to our environment.

From a complexity standpoint the key to understanding individual habits must start with social habits as they represent are the environment individuals are adapting to. In general, individuals inhabiting a social environment with unhealthy habits will also have unhealthy habits and those in healthy environments will be healthier in their choices. It is important to recognize that a self-concept could not arise without an environmental context for it to adapt to as a predictive model requires something to predict and so needs external patterns to adapt to. The ability of any individual to make healthy or not so healthy choices will reflect both the capacity of their individual predictive model and their adaptation to the social habits and choices available in their environment.

Different self-concepts with different predictive models will have different levels of predictive optimization because of their efficiency of modeling both external and internal environmental information. The predictive rules of operation that are established by an individual, constrains both the portion of environmental information which will be considered and the range of actions a person is likely to take within that environment. These sets of constraints are not short lived but will continue for an extended period of time and generally only change at the point they no longer are effective in the environment and usually because the environment has changed.

In this theory there are three major levels of self-concept predictive modeling on a progressive gradation from a basic sensory level to the healthier transcendent level. As a person moves through these levels they increase in complexity, predictive efficiency and health. As the person moves through each new level the previous level does not disappear but is subsumed within the predictive hierarchy with the highest current level becoming the new default predictive bias. The three levels of self-concept are illustrated below as they are expressed in four domains of which are, level of awareness, use of symbol as a predictive tool, scope of time/space captured in the predictive model and the source of predictive model manifestation.

Figure 1



Sensory Self-Concept

The sensory level of environmental modeling is envisioned here as a self-concept model that is the least efficient of the possible predictive optimization schemes. The self-concept at this level is validated and maintained largely through input from the senses and is body based. When a person has sensory awareness as their level of environmental action, the model of environmental interpretation and engagement is very limited in time and space. Sensory information is naturally of short duration and so goes through a rapid cycle of sensory stimulation and extinction requiring constant renewal. At this level of awareness, the person is operating moment to moment and the extreme end of this level is characterized by addictive behavior.

The depth of the connection between the sensory stimulation and the validation of the self-concept is reflected in the language the person uses to self-describe. Words will equate the sensory experience with the individual's concept of self, such as "I am a big Velveeta eater" or "I always have to have a big bag of chips". This language usage shows very little separation between the self-concept and the sensory experience that informs it. Additionally, individuals operating at this level may demonstrate existential anxiety with just the thought of having to give up a favorite food or sensory experience because it is so closely tied to the self-concept. Remove the sensory experience and you remove the validation of the self-concept. Food is not the only sensory input that can provide the basis for a sensory based self-concept, as any other sort short-lived sensory response will suffice. Examples will include smoking, alcohol, drugs, other behaviors where there is a sensory based cycle of expectation and fulfillment.

There are two behavioral threads common to any self-concept based in a sensory predictive model in that they all capture only short time frames and there is a severe limit of recognized options. Connecting these two common threads together is that short term predictions as the operational model of the system will not allow it to be informed by predictions that can account for an expanded domain of time and space. Long-term predictions are more supportive of life because

predictive error can be additionally minimized by capturing possible long-term outcomes. A sensory level of adaptive capacity will have very good short-term predictive success but very poor long-term predictive success. This emphasis on short term predictability is a source of morbidity and shortened life span through life style choices that are a recognized cause of chronic conditions such as heart disease and diabetes.

The sensory self-concept is embedded in the social context the person inhabits and is maintained by participating in that social context. Individuals will typically associate with social groups that engage in the same sensory based behavior as the individual, which creates the opportunity for social events that celebrate the shared behavior. To be a valid member of the social group that engages in the sensory behavior, can be as simple as participating in the shared behavior. At the same time, not participating in the shared behavior can lead to exclusion from group social events. The social groups that support the behavior do not have to be local but have a tendency to be small community based as it is easier to share in the common behavior.

The sensory level is problematic because it does not allow for much variation in evolutionary growth. The senses adapt to basic signals from the physical world such as chemicals, light and pressure. Honey was as sweet in Roman times as it is now, and wine was intoxicating to the ancient Greeks as it is to the modern world. Generations have passed without changes in this level of adaptive interpretation. The predictive process that has and continues to evolve is the predictive efficiency gained by the use of words and symbols which is detailed next in the Referential level of self-concept.

Referential Self-Concept

A self-concept based in a referential frame improves predictive success over the sensory level because it goes beyond the short term and rapid extinction predictive cycle common to sensory experiences by the construction of shared symbols that represent an aspect of reality and can be manipulated for better predictive efficiency. Sensory based predictions can only come about by matching patterns on the local and personal level as there is a straight forward one-on-one matching between the sensory stimulus and the corresponding sensory experience. With a common frame of reference based on a commonly shared set of symbols, two groups of people even at a great distance apart, can build the same machine from the same set of directions as long as they share the same symbology in language, math and graphics. A referential self-concept is constructed from a group defined set of predictive models expressed in the abstract through the use of words, art or other symbolic stand-ins. The frames of reference that are available vary widely and can include cultural, scientific or religious orientations.

Frames of reference from any religious, cultural or scientific source will provide guidelines for behavior and actions of an individual that lead to an outcome consistent with and supportive of the shared frame of reference. In the referential level, the frame of reference is defined by the selection and definition of symbols that represent aspects of reality creating short-cuts that then can be refined and manipulated for more accurate predictive models. These symbols may be mathematical, linguistic, iconic or one of the many art forms. The frame of reference allows the emergence of a self-concept whose predictive efficiency is of a longer duration than that of the moment-to-moment sensory based feedback and so provides a greater minimization of predictive error and improved health for the individual over that of the sensory level.

An advantage that a frame of reference has as a model for the minimization of predictive error, is that there is a sharing of ideas between people allowing for coordinated action and expanding the sources and trialing of predictive information. A frame of reference has the advantage of continuing over time and the predictive efficiency of the frame can be tested against actual experience of others using the same frame of reference allowing it to evolve and improve. In this

theory, any system of abstract representation is also a complex adaptive system that undergoes progressive evolutionary change and has the same goal as any CAS which is to minimize predictive error. In this sense the only guide to the “correctness” of any referential system is its success in the minimization of predictive error. Human social systems being CASs will adapt to the environment they inhabit and so a successful referential system in one location will not be as successful in a different social setting. The most obvious example of this is language, where in Japan, Japanese fluency is social inclusion but becomes social isolation in India.

The role of the community is more substantive in the construction of a referential self-concept than it is in a sensory one because a community is required for the development, maintenance, and transmission of community guidelines that define the shared frame of reference. The community that is the source of the frame of reference will form both formal and informal institutions with methods of recognizing authorities, creating a common literature that can be referenced and updated and include formal or informal organizational gatherings. Membership in these organizations may also be formal or informal but all require some degree of compliance by individual members with the community developed set of rules. Non-compliance with the accepted guidelines usually comes some kind of community enforcement action that may range from a reminder of social norms or a voluntary or forced loss of membership.

Membership of an individual in one of these organizations will be demonstrated by referring to the self using the language of that frame of reference. Examples of this would be “I am German”, “I am a geologist” or “I am vegetarian.” The individual operating at the referential level will also spend time accessing the organization’s literature and/or authorities for ongoing guidance. Group affinity is also an opportunity for social connection and allows a person with that frame of reference a source of validation for the self-concept based in that frame of reference.

Every predictive model has its limitations that provide an opportunity for better models to evolve for even greater minimization of predictive error. The limitations of the referential level are more difficult to conceptualize because most of us as professionals operate within a particular referential environment daily. Every frame of reference is a socially constructed model that requires some consistency across connected concepts within the frame of reference and in many cases this consistency is forced while inconsistencies can be actively ignored.

Frames of reference are super predictions that form a nested hierarchy of shared words and symbols, memes and concepts, methods of legitimizing content, people and organizational structure. No single frame of reference whether it be cultural, religious or scientific can capture all parts of the environment for the effective minimization of predictive error. Just as words, memes and other symbols can be manipulated to produce new meaning so too can frames of reference although valuable information from outside the frame of reference will have a tendency to be ignored or even actively discounted.

The need for frames of reference to define and defend a particular predictive model can cause problems for individuals who belong to more than one group. For example, in science it is possible for a person to both have a religious and a scientific frame of reference, but it is well known that crossing those organizational boundaries can cause problems and individuals often choose to separate one frame of reference from another in their lives to avoid conflict.

The predictive efficiency of the referential self-concept has hit an evolutionary stopping point because while frames of reference can and have evolved over generations, evolutionary pressure from the rapid pace of social change we are experiencing currently has become too much for any individual frame of reference to keep up with. The Transcendent level of self-concept predictive modeling sits on top of the referential level in the nested predictive hierarchy and utilizes the predictive value of frames of reference in a more flexible manner with a greater range of adaptability. The next level of self-concept, self-transcendence, is a type of predictive modeling that

allows the individual to see the self as a concept that is both real and changing at the same time and allows for the flexible use of multiple frames of reference at the same time. The transcendent level allows an individual to select the best predictive model or combinations of models from multiple frames of reference at the same time for additional predictive optimization.

Transcendent Self-Concept

Complexity research and mathematical modeling shows the concept of the self is a mental construction that is both universal and valuable. A defined concept of self creates for individuals a reliable predictive bias that has adapted to the current environment and like any predictive bias is refined continuously through interaction with the environment. The basic rule in a non-linear world is change and the fundamental state is one of impermanence. The transcendent self-concept can provide this additional minimization of predictive error and so lead to greater health.

An individual operating at the transcendent level has transcended the self-concept which provides more predictive value than either the sensory or referential levels as the predictive model is not constrained by any particular frame of reference or sensory experience. The sensory and referential frames have not disappeared but have been subsumed within the transcendent level expanding the nested hierarchy. The transcendent level is not a concept based predictive model but can hold both the impermanence and existence of the self at the same time. The transcendent level has an adaptive advantage in that it uses the previous levels selectively based on what is appropriate to the current environmental conditions. In complexity science a concept called initial conditions refers to the fact that the place where a CAS starts from partially determines its path. At the transcendent level each moment is seen as an initial condition and a first step allowing greater flexibility as to the next step on the path.

While the sensory level is mediated through the senses and the referential level is mediated through the manipulation of symbol; the transcendent level is the embodiment of symbol and is wordless. While the sensory level is perfected through sensory experience and the referential level perfected through learning and rulemaking; the transcendent level is perfected through meditation, mindfulness and a practice of compassion. This ability to see the sameness and differences in all things allows a feeling of compassion to arise naturally and an understanding is achieved that individual and group welfare are inexorably linked.

The role of the nurse is to recognize the level of adaptive capacity the person is at and work with them at that level while providing guidance to higher levels of predictive optimization. Moving to higher levels of predictive modeling is best accomplished at multiple scales with an emphasis on the social environment which is molding the behavior in the first place. The next section provides more information on the range of health behaviors across the predictive models and how the transformation of health behavior occurs through the adoption of better predictive models.

Meaning Emergence in Health behavior change

Working as a diabetes nurse educator, it has always amazed me that people of integrity who have no problem fulfilling promises with their families or in their professional lives, more often than not fail when it comes to keeping a promise they have made to themselves about their health. We know that health behavior change is extremely difficult from both personal and professional experience. Despite the application of tremendous effort and resources, our record of success in changing health behavior is uneven at best and ineffectual at worst. A part of the issue may be that we are viewing the problem through our linear bias which is to identify a knowledge or practice gap, provide the necessary information and we are done, the rest is up to the patient. This conceptualization continues the linear bias of viewing the patient as a machine where we

just need to supply the required part, in this case missing the information. Viewing the patient as a machine to be fixed distorts the professional-patient relationship creating divisions in process and expected outcomes. I saw the impact of this division while working in diabetes education, one of the most common reasons for referral I would get was for non-compliance. Non-compliance with food, medication or follow-up although the weirdest one I ever received was non-compliance related to a new diagnosis of diabetes. Who can be compliant when they did not know that they had diabetes? Labeling a patient as non-compliant helps no one and sets up a division where one does not belong.

Complexity theory tells us that or the most part patients have adapted to their social environment and simply providing information does not change the social environment and is trying to solve the wrong problem. Health behavior cannot be fixed separate from the environment it occurs because health is so fundamentally interconnected. Understanding the process of health behavior change informed by complexity theory may help us bridge this divide between patient and health practitioner.

Before we get into how complexity informs behavior change in individuals, a quick synopsis of what we learned in chapter five. The level of self-concept as reflected in the adaptive capacity exists because there is a portion of the environment that it has adapted to and because the self-concept has adapted to a part of the environment it will have a tendency not to change as long as is supported by that part of the environment. It may even be possible that the reason certain individual health behavior patterns exist is that it is they are the behavior patterns that fit best with the predominant social behavior patterns that are available in the environment. Healthy behavior may not be dominant because the social environment does not support it.

This could quickly become a chicken versus egg argument, but complexity theory has a solution to the issue of which came first individual behavior or social behavior called co-evolution. Individual health behavior and social health behavior evolve together because they are an interdependent predictive hierarchy. The individual feeds predictive information to the group along with the predictions of other group members for the generation of a group prediction. At some point the predictive capacity which drives health behavior for a person will be forced to change either because the environment has changed, and that behavior is no longer supported, or the predicted results are not supportive of life. A great example of this is a study of the change in smoking health behavior in Framingham Massachusetts that showed a dramatic decrease in the rate of smoking between 1971 and 2001. Individuals may have decided to change their behavior on their own because of information about the deleterious effects of smoking but the research indicated that this was not the primary factor driving the change. Individual smoking behavior decreased mostly because smoking became socially unpopular. The social environment had changed with new standards based on changes in regulations and social expectation. At one point in American history smoking was socially supported and even encouraged but at a later point it was not. It is not that it become impossible for individuals to smoke, it just became much harder as it was not supported by the environment anymore.

Interventions to change health behavior

Health behavior is an interdependent predictive process based in the hierarchy of interaction between individuals and their environment. To have successful and sustained health behavior change, intervention is required at both the individual and the social level although in this chapter we are only addressing interventions to change individual behavior. There is no doubt that behavior changes both consciously as they identify changes they want to make and subconsciously as the environment changes and the old behavior is no longer adaptively optimal. Interventions to minimize predictive error at the social level will be explored in the next chapter.

Revisiting the complexity science definition of health “Health is the scale-free, continuous evolutionary global process of minimization of predictive error. The goal again is continued existence of the entire system and making the best predictive model for the evolving environment. When considering how complexity theory might relate to existing health behavior theory one theory that particularly stands out is the Transtheoretical model. Popularly known as the stages of change theory, the Transtheoretical Model is an observational model that says that people go through a defined number of stages with any health behavior change. Each of the stages must come in sequence and stages all must be transversed before a permanent change is made. Interventions that have been demonstrated to assist people in moving from stage to stage on their way to permanent change have been identified using the theory.

Each stage of behavior change in the Transtheoretical model can be seen as single step on a biased random path leading to the emergence of more complex levels of meaning to increase health by minimizing predictive error. Specifically, this means to move from a less efficient and complex predictive model to a more efficient and complex one. This statement belies the actual two-part process that is required for success. Not only must the model change with the creation of the new habit but the person must also find an environment where they can practice the new habit. The fact that a person must not only change themselves but also their environment is what makes behavior change so difficult. Because on one individual can change an environment all by themselves the more effective option is to engage with a new environment. This of course has its own problems as anyone who does so may sour other social relations including family, friends or even employment. Even as a diabetes nurse I was told I was not a team player because I did not want to participate in the annual cookie exchange. It did not matter that if I did I would have ended up with seven dozen cookies for me, my wife and the dog.

In conforming to the complexity definition of health, a person will seek out the environment that supports their existing predictive bias. There is often talk of the role of motivation in health behavior change. In this theory the presence of motivation towards health indicates a perceived need to move out of the current level of predictive capacity into a more complex one. For the purposes of clarity, the explanations the table below of the different stages of change are taken directly from the source article

Table 3

Stage of Behavior Change	Transtheoretical explanation	Complexity explanation
Precontemplation	"People are not intending to take action in the foreseeable future, and can be unaware that their behavior is problematic"	The current predictive model is working well because either there is not sufficient information in the environment to force a change or the person has been able to isolate himself or herself in a part of the environment that supports their current model.
Contemplation	"People are beginning to recognize that their behavior is problematic, and start to look at the pros and cons of their continued actions"	There is sufficient information in the environment that a change may be needed. Gaps in predictive error of the current model are being explored.
Preparation	"People are intending to take action in the immediate future, and may begin taking small steps toward behavior change"	Alternative predictive models are being contemplated and compared on anticipated effectiveness. This is largely a mental process but may include short practical trials.
Action	"People have made specific overt modifications in modifying their problem behavior or in acquiring new healthy behaviors"	The new predictive model with the greatest anticipated chance of success has been selected and is being implemented

Maintenance	"People have been able to sustain action for a while and are working to prevent relapse"	The previous predictive model and the current one are in competition. Often both the internal and external environments will be supportive of the previous model.
Termination	"Individuals have zero temptation and they are sure they will not return to their old unhealthy habit as a way of coping"	The new predictive model has become dominant and the old one has been subsumed into the predictive hierarchy and a suitable environment to practice has been identified.

Each of the stages will be explored more here to highlight the insight that complexity theory brings to behavior change along with an examination of interventions that may help and those that may not. Pre-contemplation, in some ways precontemplation is a non-stage for the person because it is not visible to the person. Their current model is working well enough for them that it does not seem to need changing. In this stage when there is a push to change it will come from the outside, possibly with a change in circumstances, a concerned friend or family member or as often occurs with health issues an encounter with the health system and some input from a health professional. This is a difficult stage to advance from because our bias is that our model is working for us and if it wasn't we would have known it. So, the default is disbelief and if there is the possibility to dialogue it is through listening and following the questions the person asks or asking how they take it. It is not generally helpful to simply provide more information when the first that was provided was discounted. Successful behavior change is a path and the wise health practitioner will follow along on that path with the patient allowing them to learn in their way and at their speed.

Contemplation is the next step on the path to behavior change and is where the person is more directly involved. According to the UTME all predictive models will have some level of predictive error, but the error will be tolerated until it reaches a point of discomfort. In the contemplation stage the person is testing this level of discomfort and deciding if a change will be valuable. The strength of the contemplation will largely depend of the source of knowledge for the predictive error. The strongest disconnect will come with input from the social environment. All habits are interdependent with social habits and so will come into conflict when social habits change. This is exactly the same as trends and fashions. The gap with social habits is entirely dependent on the part of the environment the person engages with. Unfortunately for the influence of health care practitioners, most people interact very little with the health care system and so the gaps identified here potentially do not carry nearly as much weight. Even if the patient were to agree with our assessment of their predictive gap, they still have to go back and negotiate that with their social environment.

Once a person gets to the preparation stage they have essentially agreed that there is an amount of predictive error that is concerning and so the person starts exploring possible new predictive models for the one that may work for their individual situation. It is important to emphasize the individual situation here because according to complexity science successful action on one environment will not have the same level of success in a different environment. The new predictive model that is chosen may itself be a negotiation with the social environment the person lives in and may even be a new habit that is preferred by the social environment. A post stroke patient may not go back to an environment that is supportive of a diet that decreases the chance of a second stroke.

In Preparation the exploration is largely mental exploring new ideas conceptually but may include short trials. The end of the Preparation stage is with the selection of a preferred new habit with internal and external indicators that a new path is chosen. This can be a difficult time as other members of that person's social environment will often feel free to comment on the persons chances of success or failure with the new habit. The new habit may also be unfamiliar to the person because they have no one in their social environment who is practicing it. The lack of identifiable mentors can make a person feel alone.

The action stage has the person practicing the new habit with some level of consistency but because it is not a true habit there will need to be a strong system to remind the person of the new habit. There is also likely to be feelings of loss for the old habit and questioning the value of the new habit. Social support for the new habit will largely depend on the level of general engagement. If the new habit is an expansion of the self and a more complex one there may be a feeling of elation.

Maintenance stage represents the difficulty in disengaging with previous individual and social habits. It is during this period that the influence of social habits becomes most evident. Members of any social group are always judging their behavior against that of the group. When a single individual not engages in the socially sanctioned activity they threaten their membership in the group. I have had patients lose friends when they choose something healthy because the other people in the group who have not changed their behavior feel judged. The loss of social relations may have even greater consequence than the loss of a formally enjoyed habit. This peer pressure is what makes the final stage in the path of behavior change difficult and rarely achieved.

The Termination stage is the final stage and it is where the person has both solidified the new habit and found an appropriate environment to practice that behavior. Remarkably this stage is not included in every iteration of the Transtheoretical model. The narrative people have when they reach this stage is one of transformation and they talk about themselves as if they are different people. In the termination stage not only have you changed your individual habits but most likely you have found a portion of the environment that is supportive of your new habit. In the UTME, more people will reach the termination phase because the environment has changed enough to facilitate that change.

Meaning emergence in the human environment

The real value of nursing's unitary human-environment perspective of process is most evident in the area health as it relates to the social and natural environments. Complexity science in general over emphasizes the individual even in the use of big data and agent-based modeling. We feel as if our choices are independent and of our own volition while ignoring the fact that we are all a part of a larger social system that effectively constrains our choices. The emergence of new words depends on a simultaneous change in social meaning, which occurs in the shared meaning of the new word in the social space between people and a simultaneous change in the brains of the individuals who come to understand this new word. The emergence of word meaning within the individual brain and the emergence of the social meaning of a word between individuals is a great example of coevolution or mutual adaptation throughout the nested predictive hierarchy that is a complex adaptive system. As the larger social system changes with the introduction of a new word then the individuals that are a part of the social system must also undergo a change in each of their brains or otherwise the whole thing does not hold together. The same principle of coevolution is the best way to understand the relationship between health behavior patterns at a community level and the health behaviors of that community's individual members.

Human social systems evolve to greater predictive efficiency

Social systems continue their existence by maintaining, transmitting, enforcing and correcting social information. While knowledge is passed down there is also an undeniable trend for the increasing complexity and evolutionary progression of knowledge and social systems. This social evolution that is taking place is of the same quality as other complex adaptive systems with an overall decrease in system-wide predictive error. The interdependent connection between individual and environmental health is the one least explored by complexity science to this point although some thinkers have conceived of the Human/Environment connection as a whole system as in the principle of Gaia and Gaia 2.

Is compassion the most efficient human system?

The implication of the definition of health is as follows: The health of one part of the system cannot be isolated mathematically or functionally from another part because for the predictive efficiency of any part of the system to be minimized; the predictive efficiency of the entire system must also be minimized. A highly efficient society from a predictive optimization standpoint would also value the contribution of each individual. No system knows the full extent of what will be required of it and so has some slack and redundancy to cope with the unexpected. In the individual, predictive optimization is found in the mindful state of compassion. A truly complex adaptive system would maintain the adaptive capacity of all individuals and seek to continually enhance their level of adaptive capacity because any society is only as good as the capability of its individuals.

Sick Nurse, Health Nurse

A common way to divide the broad range of health services into reasonable categories of understanding is to put them into stages of prevention most widely known as Primary, Secondary and Tertiary prevention. Currently nursing is largely practiced within institutions that deal almost exclusively with identifying and treating disease or decreasing the risk of problems arising from disease. The science of public health has added a fourth stage to this concept called primordial prevention, that it is not as well-known to nurses and other health providers outside of public health. This is necessary because while the treatment of contagious diseases and the repair of disabling injuries has seen tremendous advancement over the last century because of the great success of reductionism, the same cannot be said with stemming the rising tide in the increasing rates of obesity, heart disease and diabetes. The standard disease focused approach is to work at one of the stages of prevention which are listed in the table below. The Unified Theory of Meaning Emergence adds a new stage of evolutionary prevention to the table in bold at the top is this new level of prevention which is a conscious co-adaptation of the unitary Human-Environment process. An additional column has been added to the table indicting the impact of each level has on the minimization of predictive error.

Stages of prevention

Name of level	Goal of action	Types of actions	Impact on efficiency of Predictive Error minimization
Evolutionary	Improving resilience, expanding social intelligence and compassion	Social and individual Compassion	Improves
Primordial	Prevent the development of risk factors Stability of homeostasis	Early education on healthy lifestyle	Short Term Stability
Primary	Risk factors are present and try to stop a condition before it starts	Health education Genetic screening Good nutrition	Decreased efficiency

Secondary	Identify and intervene in a disease early	Disease screening Aggressive treatment	Decreased efficiency
Tertiary	Care after a disease or condition has occurred	Rehabilitation Pain control	Decreased efficiency

The complexity definition of health says that health is not just the prevention of disability but is a continuous evolutionary process. Prevention must include how to develop adaptive capacity to make better predictions about what we do know and to deal with what is not yet known. Our modern environment while advanced can cause its own disease conditions. A level of prevention that is beyond primordial prevention that recognizes the inevitability of increasing complexity. Nurses work on the leading edge of developing complexity whether it is at the individual, family, national or global level. The work in these traditional institutions will continue but there is another level of activity that is beyond preventative and is supportive of the continuously evolutionary process of meaning emergence. The concern at this more advanced level is with continuous improvement in the individual and environmental is where the majority of nursing work will be in the future. The nursing profession of the future will have expanded avenues of practice by moving past the medicalization of health to a practice of improving health through the promotion of individual and social compassion.

Meaning emergence and the nursing science of compassion

Overview: Unitary human-environment becoming process Nursing is a unique scientific profession that embraces the story of the whole person using science to craft a path to health for individuals and communities. The current division between the care of the whole person and the science of the parts in nursing's process of caring and healing, has been driven by the medicalization of health that concentrates on the parts of a person. The assumption is that unhealthy parts are the cause of an unhealthy whole and to fix the whole we must fix the parts first. Nurses have historically taken this same approach with a misreading of Maslow's hierarchy in that we address an individual's health needs starting from the bottom of Maslow's pyramid with basic physiologic needs before moving to the top. Physiologic needs are seen as more fundamental and come before the much more complex needs of self-transcendence. Prioritizing health needs this way would make sense if the needs of the person before us were truly critical, which isn't true in the vast majority of nursing practice settings. Even within the realm of the emergency department, most patient encounters are at best urgent and do not reach the level of true emergency forcing care to start with live saving interventions to restore basic physiologic needs.

Evolution of Human-Environment health

The evolution of human knowledge and society is undeniable. Besides the obvious improvement in scientific and technical knowledge, there have been major decreases in violence, war, and paternalism with increases in international cooperation on global issues. This change in human social systems reflects an increase in individual and collective capacity to efficiently sustain the functioning of the global system. This leads to a new conceptualization of health care and nursing that is not satisfied only with stability but is supportive of individual and collective evolutionary progress.

If the health of the person is inseparable both mathematically and conceptually from the parts of a person and from the environment the person lives in; what then is the role of the nurse in promoting health? Taking what we have learned from complexity science there are a few things that immediately jump out. The first is to start from the largest stage possible because that is where you will have the greatest and most long acting effect. Starting health improvement from the largest stage is the idea that turns Maslow's hierarchy on

its head. We will have a better chance of healing the parts of a person if we start with individual first. We will have a better chance of caring for the individual if we start with the family first. We will have a better chance of healing the family if we start with the society first and so on. But just like any complex system, work to improve health can and will happen at all levels simultaneously.

Returning to the complexity definition of health in the conceptual frame; “For any living system, health is the simultaneous, continuously dynamic and adaptive search for the global minimization of predictive error at all levels of the system for the mutual benefit and continued existence of the system as a whole.” To improve health means to improve adaptive capacity by increasing the accuracy of predictive models throughout a system and that means closing the predictive error gap through the evolution of better predictive models.

This new definition of health will lead nurses to work from two new paradigms.

1. The most efficient state of adaptive capacity is one of compassion/mindfulness whether it be for the patient, the nurse or the society. The nurse her/himself will only be maximally effective if they practice in a mindful/ compassionate manner.
2. A modification of the environment is required for the improvement of individual health. The nurse cannot work at only the level of the patient but must like Nightingale consider all of the aspects of the healing environment.

These two paradigms can be summarized in the following statement of the role of nursing:

“The role of the nurse is to live compassionately and relieve the suffering of others.”

Florence Nightingale felt that the role of the nurse extended beyond the confines of the ward and that the character of the nurse was vital to the healing relationship. The nurse of the future will work with a client at all levels essentially at the same time because the competent nurse understands the unavoidable connection between all of them. Nurses will demonstrate not only the intelligence and skill of competent practice but also the equanimity and compassion that comes with a practice of mindfulness. Nursing is uniquely situated among all health professions to work at all of these levels. From community nursing to intensive care, the goal of nurse will be to practice compassion and promote compassion with the patient and their environment. At each level the nurse operates as the visionary that helps their client whether it be a nation or an individual to see what is possible at the next step.

References:

Arganda, S., Pérez-Escudero, A., de Polavieja, G. (2012). A common rule for decision making in animal collectives across species, *Proceedings of the National Academy of Sciences*, 109 (50) 20508-20513; DOI:10.1073/pnas.1210664109

Banerjee, K., Kolomeisky, A., & Igoshin, O., (2017). Elucidating interplay of speed and accuracy in biological error correction. *Proceedings of the National Academy of Sciences* May 2017, 114 (20) 5183-5188; DOI:10.1073/pnas.1614838114

Churrua, J., Vigil, L., Luna, E., Ruiz-Galiana, J., & Varela, M. (2008). The route to diabetes: Loss of complexity in the glycemic profile from health through the metabolic syndrome to type 2 diabetes. *Diabetes, metabolic syndrome and obesity: targets and therapy*, 1, 3-11.

Friston, K. (2013). Life as we know it. *J. R. Soc. Interface*, no. 86. DOI: 10.1098/rsif.2013.0475.

Garrison, K., Zeffiro, T., Scheinost, D., Constable, R., Brewer, J., (2015). Meditation leads to reduced default mode network activity beyond an active task, *Cognitive, Affective & Behavioral*

Neuroscience, 15:3, pp 712–720

Goldberger, Ary. (1991). Goldberger, A. L. Is the normal heartbeat chaotic or homeostatic? *News Physiol. Sci.* 6, 87-91

Gopnik A. and Tenenbaum J. (2007). Bayesian networks, bayesian learning and cognitive development., *Developmental Science*, 10 281-287.

Heeger, D. (2017) Theory of cortical function, *PNAS*, 114 (8) 1773-1782; <https://doi.org/10.1073/pnas.1619788114>

Kiebel, S., Daunizeau, J., Friston, K., (2008). A Hierarchy of Time Scales and the Brain, PLOS, <https://doi.org/10.1371/journal.pcbi.1000209>

Krakauer, J., Ghazanfar, A., Gomez-Marin, A., Peppe, D., (2017). Neuroscience Needs Behavior: Correcting a Reductionist Bias, *Neuron*, 93(3):480-490. doi: 10.1016/j.neuron.2016.12.041.

Lipsitz, L., & Goldberger, A., (1992). Loss of ‘complexity’ and aging. Potential applications of fractals and chaos theory to senescence. *JAMA* 267:13 1806-9

Meunier D, Lambiotte R, Fornito A, Ersche KD & Bullmore ET (2009). Hierarchical modularity in human brain functional networks. *Front. Neuroinform.* 3:37.

Mooney, C. G. (2000). Theories of childhood: An introduction to Dewey, Montessori, Erikson, Piaget, & Vygotsky. St. Paul, MN: Redleaf Press

Paul, M., Zucker, I., Schwartz, W., (2007). Tracking the seasons: the internal calendars of vertebrate, *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363 <http://doi.org/10.1098/rstb.2007.2143>

Smith, M., Fitzpatrick, J., (2019). Perspectives on the Unitary Transformative Person-Environment-health process, *Advances in Nursing Science*, 42:1, 43-57

Wacongne, C., Labyt E., van Wassenhove V., Bekinschtein T., Naccache L. & Stanislas D. (2011). Evidence for a hierarchy of predictions and prediction errors in human cortex. *Proceedings of the National Academy of Sciences* 108 20754-20759.

Wang B., Yan, N., Liwen, M., Cao Rui, Pengfei, Y., Hao, G., Dandan, L., Yuxiang, G., Tianyi, Y., Jinglong, W., Jie, X., Hui, Z., (2017). Decreased Complexity in Alzheimer's Disease: Resting-State fMRI Evidence of Brain Entropy Mapping, *Frontiers in Aging Neuroscience* VI9 P. 378 <https://www.frontiersin.org/article/10.3389/fnagi.2017.00378>