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# Complexity and Food

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Complexity as a theory for how systems work and maintain stability is a popular topic today in many fields, including physics, chemistry and mathematics. These concepts have even entered the popular consciousness, with references to it in such films as *Jurassic Park*. The various theories about complexity also have validity in the area of diet and health. How can complexity theory clarify our understanding of food quality? And can complexity theory have practical application in the way we eat?

What has research found that points the way toward understanding how complexity is a component of what makes us tick? Let's start with some general observations. At its best, food is a vastly complex and synergistic mix of various nutrients. Processed foods have fewer nutrients and lean heavily toward specific macronutrients. They also reduce micronutrients often found in whole foods. In addition, nutrients are altered in ways not found in traditional food processing. As such, modern processed foods are simpler than the full bodied complex foods of antiquity.

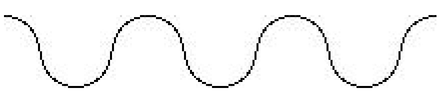
For the moment, let's assume that complexity in food can be associated with higher quality and simplification in food with lower quality. Can the relative complexity of food be imparted into our tissues? This is important, because higher complexity in human tissues has been linked to vitality and health.[1, 2]

Here's a simple analogy. If a table has one hundred legs (a very stable complex structure), and we shoot a bowling ball at 100 mph under the table, we might knock 50 legs out from under the table. But with 50 legs still intact, the table remains secure. However, if there are only three legs to the table and we knock out only one, the table falls over. Higher complexity yields higher stability in response to stress.

Two studies in electromedicine are worth reviewing. Both were conceived by Dr. Michael Heffernan, who operates a pain treatment clinic in Texas. The first study judged the increased electromagnetic complexity imparted to the brain using electrical stimulation in the microcurrent range (currents were less than 600 millionths of an ampere).[1]

One way Heffernan judged complexity was by using EEG spectral analysis which is easy to understand with a little background from the physics of music.

A sine wave is a simple frequency with no harmonics. Harmonics are pitches that are present in musical notes, and help us hear the difference between two different people singing or two instruments. A sine wave (which has no harmonics) looks like this:



Most sounds we hear have multiple frequencies present above the lowest pitch (or fundamental pitch). They have a complex pattern. It's easy to tell the difference between your best friend singing a B-flat and Luciano Pavarotti singing the same note. You can also tell the difference between a clarinet, flute, piano or xylophone sounding that very same note. If the note (fundamental) is the same, how it is possible to tell the difference between multiple sources?

We distinguish between each source of a note by the pitches (harmonics) above the fundamental. These harmonics give the tonal quality to every person's voice, and to each instrument, and add richness to our aural experience. Remarkably, these harmonics are so important to our sense of the sound world that if the fundamental, or lowest, pitch is removed electronically, we still hear the same note! It will be a little softer but will still sound like the voice or instrument that we heard before. This demonstrates the importance of the complex arrangement of harmonics above the fundamental. If we keep removing pitches from the fundamental, the pitch keeps getting softer and, after a while, it's hard to tell exactly what the source of the note was.

Harmonics fill in the hills and valleys in a sine wave, making it more complex in nature. The more harmonics, the more complex the note. The more complex it is, the more a sine wave begins to look like a smooth line, with all the hills smoothed off and the valleys filled in.

In electromedicine, sine waves are injurious to human tissues! Perhaps it's because they are too "simple."

This is what Dr. Heffernan was exploring in the human brain in his first study. He used EEG measurements from the brain and measured the relative smoothness of the waves in patients with chronic pain, anxiety, depression or insomnia. Lower complexity in these EEG measurements is associated with the symptoms above, and higher complexity is associated with amelioration of these symptoms. In other words, when we maintain a highly complex state, we are more stable, happier and our capacity to heal is enhanced.

Heffernan found that delivering a highly complex wave form in the microamperage range imparted higher complexity into the brain and resulted in a reduction of symptoms. But the fun is just beginning!

In his next study, Heffernan measured relative complexity in knees and elbows.[2] Once again, in every case he examined, relatively high complexity was found in healthy joints and relatively low complexity was found in joints with chronic pathology. Interestingly, in joints with acute pathology, such as a bad sprain, as long as the complexity was sustained, healing proceeded nicely. Only with low complexity in a joint was chronic disease present.

By applying a highly complex wave form, Heffernan was able to objectively measure an increase in the complexity of diseased joints, which yielded a reduction in symptoms.

Let's use non-technical terms to understand what all this means. When we take in electromagnetically complex "information," we aid our body's ability to maintain high complexity and, hence, health and vitality. I believe this same principle is in play when we nourish ourselves with whole, nutritionally complex food. Thus, it may be useful to judge whole food by its relative complexity as compared to modern processed foods. Wouldn't you prefer to be as stable as the table with one hundred legs rather than unstable, like the three legged table?

**REFERENCES**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2. The Effect of Variable Microcurrents on EEG Spectrum and Pain Control, Dr. Michael Heffernan, Canadian Journal of Clinical Medicine, November 1997, Vol. 4, #10.


**Sidebar articles**

## Complexity in Food

Processing strips our foods down to their simplest components sucrose in white sugar, glucose in white flour, filtered vegetable oils, pasteurized reduced-fat milk products and artificial flavors. These processes also remove the vast array of nutrients that work together synergistically in whole foods. The food industry has long claimed that the removal of nutrients can be rectified through "fortification," the addition of synthetic vitamins. For example, synthetic vitamin A is added to margarine to make it "nutritionally equivalent" to the natural vitamin-A complex in butter. However, synthetic vitamins can cause imbalances and often have undesired effects. Synthetic vitamin A has been shown to *cause* the type of birth defects that natural vitamin A prevents.

Lately, there is a huge push to get women to take supplementary folic acid to prevent neural tube defects during pregnancy. Folic acid by itself it a simple nutritional constituent. It's only one nutrient in thousands that are a part of whole, nutritionally complex foods. While it is claimed that supplying this nutrient in pill form may have a positive effect in reducing neural tube defects, why are women told that this is what they need rather than being given a choice between supplementation or a diet of whole foods that provides this nutrient in context? Is this ignorance or rationalization? Either way, it seems more respectful to fully inform the public rather than simplifying the truth and giving women an uninformed choice. Lack of whole foods is the root cause of folic acid deficiency, not a lack of pills.

## Complexity in Farming

Industrial farming is characterized by monoculture of crops and processed rations for farm animals. In monoculture, huge expanses of land are planted with the same seed, usually corn or soybeans. Lacking diversity, these crops are more vulnerable to pests and plant diseases and, therefore, require more pesticides. This system is comparable to the three-legged table. If one component of the system breaks down, the whole table collapses. Such was the case in the Irish potato famine. The vast majority of plantings consisted in just one type of potato; when blight hit, all fields succumbed. Famine could have been avoided with an agricultural system that stressed diversity rather than a single cash crop.

Likewise, animals in confinement are given “scientifically formulated” rations that cannot compare with the complexity of plant and insect life that animals ingest in the field. When disease hits, animals are treated with strong drugs which may be effective in the first or second generation, which lose their effectiveness over time. As long as specialists in animal nutrition think only in terms of basic components protein, fat, carbohydrates and a few nutrients the problems will remain unsolved. The solution is a return to a mixed-farming system, which fosters complex interactions between animal life and a rich variety of crops.