

# The GH-Method

---

## **Viscoelastic or Viscoplastic Glucose Theory (VGT #107): Applying the Tools of Viscoelasticity and Viscoplasticity Theory to Space Domain, Wave Theory in Time Domain, and Fourier Transform in Frequency Domain to Investigate the Psychological Symptoms versus Psychological Stimulations During the COVID-19 Pandemic Period for Borderline Personality Disorder Patient and Psychologically Normal Person Based on GH-Method: Math-Physical Medicine (No. 697)**

**Gerald C. Hsu\***

eclaireMD Foundation, USA

**Keywords:** Viscoelastic; Viscoplastic; Borderline personality disorder; Carbohydrates; Sugar; Walking k-steps; Postprandial plasma glucose; Fasting plasma glucose; Type 2 diabetes; Fast Fourier transform

**Abbreviations:** BPD: borderline personality disorder; FFT: fast Fourier transform; T2D: type 2 diabetes; PPG: postprandial plasma glucose; FPG: fasting plasma glucose; FD: frequency domain; SD: space domain; TD: time domain; MPM: math-physical medicine

### **1. INTRODUCTION**

This article presents an investigation and its results comparisons of internal energy generated through the combined interactions of psychological symptoms and stimulations over 10 quarters during the COVID-19 pandemic between a normal person (normal) and a borderline personality disorder (BPD) patient. This particular research work is conducted in five steps as described:

First, the author selects one person with no known psychological disorder (normal) and one patient who has been diagnosed with a severe borderline personality disorder (BPD). Note: No personal identity has been revealed.

Second, he performs interviews with both normal and BPD using a style of casual conversation and keeps the contents in a form of question and answer format.

Third, he quantifies the answers from the interviews into different numerical numbers and then inputs them into the computer

software, the Mental Index model (MI). He developed the MI model in 2014 for his metabolism index research work on internal medicine which uses the concept of topology, engineering finite element model, and nonlinear geometric algebra operations.

Fourth, he separates the entire COVID-19 period from 1/19/2020 to 6/30/2022 into 10 different calendar quarters. The two individuals' stimulations have created varying reactions and scales with coping during the COVID pandemic, i.e. symptoms, which are dramatically distinct from each other. With his best effort and personal judgment, he converted all of the verbal communication information into a set of numerical numbers and then entered them into the MI model.

Fifth, he entered the quarterly data of symptoms (outputs) and stimulators (inputs) for both normal and BPD into the Excel spreadsheet to conduct the 3 planned separated energy analyses: time-domain squared simulator values, space-domain

viscoelastic/plastic strain-stress hysteresis loop areas, and frequency-domain fast Fourier transformed frequency curve areas. The results from the three analyses have provided the associated energy levels of stimulation input & symptom output. The elevated area number means the higher energy level associated with the psychological stimulation and symptom during the COVID pandemic period.

The author has self-studied abnormal psychology since 2002 and established five psychotherapy centers to take care of 200+ abused women and abandoned children from 2006 to 2010. Due to professional ethics and practical concerns regarding patients' confidentiality, he cannot reveal any of their identities and stories, or use any of the previously collected information. Therefore, in this study, he utilized two separate individual cases in hopes they represent a larger pool of real cases.

Psychology is an empirical science that is easier to describe in words about stressors or stimulators (causes), behaviors, or reactions (symptoms). However, it is much more difficult to describe them in numbers or equations for a deeper and quantitative understanding of the psychological behavior patterns. That is why most psychological research work is, at best, based on statistics only, and not on other branches of natural science, such as physics and mathematics.

During the period from 2002 to 2010, the author has read approximately 100+ abnormal psychology books and 500+ clinical reports. Based on his learning, he attempted to develop "scientific-based equations" to have a quantitative and high-precision approach to researching abnormal psychology. This article is one of his continuous attempts to do so. Here, the word "scientific" means observing physical phenomena, applying physics principles, deriving mathematical equations, building engineering modeling, utilizing computer and artificial intelligence tools, and not relying on statistics alone. However, it is difficult for him to collect and utilize the data from patients with Personality Disorder (PD) without breaching professional ethics and patient confidentiality. The author hopes to continue his psychological research effort by using more of his developed math-physical medicine (MPM) approach. He appreciates

the invaluable inputs, comments, criticisms, and suggestions from colleagues regarding the area of abnormal psychology.

## 2. METHODS

The author applies various theories and tools, including linear elasticity, nonlinear plasticity, wave theory in the time domain (TD) with fast Fourier transform into a frequency domain (FD), viscoelasticity, and viscoplasticity from physics and engineering disciplines to his selected medical research subjects. He conducts this psychology research regarding the relationship between a single symptom biomarker with 6 output elements versus a single stimulation biomarker with 6 input elements.

For reference, the author lists 6 selected psychological stimulation factors and 6 psychological symptoms of BPD patients during the COVID pandemic period:

6 stimulators:

- Negative COVID news
- Fear of COVID fatality
- Childhood memory flashback
- Normal life routine disturbance
- Stress from children's stay-at-home
- Long-lasting quarantined lifestyle

6 symptoms:

- Anger
- Anxiety
- Fear of abandonment
- Depression
- Mood swing
- Tension within family

Here is a brief explanation of the three distinctive energy analysis approaches used in this study:

The first approach is to estimate the TD energy associated with waveforms of the input stimulator by calculating and comparing the squared amplitude of the average stimulation. Basic physics taught us that "the energy carried by a wave is directly proportional to the square of this wave's amplitude". The TD energy is the squared stimulation value.

The second approach is to apply the viscoelastic or viscoplastic glucose theory (VGT) to construct a set of space-domain (SD) diagrams with stress-strain curves and then by calculating the enclosed area of the SD strain-stress curves or hysteresis loop to obtain its SD-VGT energy. The SD-VGT method is useful in investigating the “time-dependent” biomarker behaviors which apply to the majority of situations in the fields of medicine, economics, psychology, and others. The SD-VGT energy is the hysteresis loop area size. The following 2 defined equations from viscoelasticity or viscoplasticity are utilized to study the stress-strain relationship in this case. Here, he wants to use the strain rate multiplied with the viscosity factor as the stress component:

Strain

$$= \epsilon$$

= individual output symptom value, at the present time

Stress

$$= \sigma$$

$$= \eta * (d\epsilon/dt)$$

$$= \eta * (d\text{-strain}/d\text{-time})$$

= (viscosity factor  $\eta$ , i.e. stimulator) / (normalization factor) \* (output symptom value at present time - output symptom value at previous time)

In a VGT study, we must carefully choose appropriate “normalization factors”, i.e. a factor associated with the “break-even line’s value between healthy condition vs. unhealthy condition”. However, in this study, the normalization factor is 1.0 which resulted from the design of his MI model.

The third approach is to develop a newly-defined variable of (strain \* stress) from SD as the new wave amplitude in a TD and then go through a fast Fourier transform (FFT) operation to calculate the enclosed area of this new variable created frequency curve in FD as the FD energy. The FD-FFT energy is the enclosed area of this frequency curve.

### **2.1 Elasticity, plasticity, viscoelasticity, and viscoplasticity (LEGT & VGT)**

The difference between elastic materials and viscoelastic materials (from “Soborthans, innovating shock and vibration solutions”).

What are elastic materials?

Elasticity is the tendency of solid materials to return to their original shape after forces are applied on them. When the forces are removed, the object will return to its initial shape and size if the material is elastic.

Medical analogy: The medical application is when cause or risk factors are reduced or removed, the symptoms of certain disease would be improved or ceased.

What are viscous materials?

Viscosity is a measure of a fluid’s resistance to flow. A fluid with large viscosity resists motion. A fluid with low viscosity flows. For example, water flows more easily than syrup because it has a lower viscosity. High viscosity materials might include honey, syrups, or gels – generally things that resist flow. Water is a low viscosity material, as it flows readily. Viscous materials are thick or sticky or adhesive. Since heating reduces viscosity, these materials don’t flow easily. For example, warm syrup flows more easily than cold.

What is viscoelastic?

Viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Synthetic polymers, wood, and human tissue, as well as metals at high temperature, display significant viscoelastic effects. In some applications, even a small viscoelastic response can be significant.

Medical analogy: Viscoelastic behavior means material has “time-dependent” characters. Biomedical data, i.e. biomarkers, are time-dependent due to body cells are organic which changes with time constantly.

Elastic behavior versus viscoelastic behavior

The difference between elastic materials and viscoelastic materials is that viscoelastic materials have a viscosity factor and the elastic ones don’t. Because viscoelastic materials have the viscosity factor, they have a strain rate dependent on time. Purely elastic materials do not dissipate energy (heat) when a load is applied, then removed; however, a viscoelastic substance does.

Medical analogy: Most of the biomarkers display time-dependency; therefore, they have both change-rate of time and viscosity factor behaviors. Viscoelastic biomarkers do dissipate energy when a causing force is applied to it.

The following brief introductions are excerpts from Wikipedia:

“Elasticity (physics):

The physical property is when materials or objects return to their original shape after deformation.

In physics and materials science, elasticity is the ability of a body to resist a distorting influence and to return to its original size and shape when that influence or force is removed. Solid objects will deform when adequate loads are applied to them; if the material is elastic, the object will return to its initial shape and size after removal. This is in contrast to plasticity, in which the object fails to do so and instead remains in its deformed state.

Hooke's law states that the force required to deform elastic objects should be directly proportional to the distance of deformation, regardless of how large that distance becomes. This is known as perfect elasticity, in which a given object will return to its original shape no matter how strongly it is deformed. This is an ideal concept only; most materials that possess elasticity in practice remain purely elastic only up to very small deformations, after which plastic (permanent) deformation occurs.

In engineering, the elasticity of a material is quantified by the elastic modulus such as the Young's modulus, bulk modulus or shear modulus which measure the amount of stress needed to achieve a unit of strain; a higher modulus indicates that the material is harder to deform. The material's elastic limit or yield strength is the maximum stress that can arise before the onset of plastic deformation.

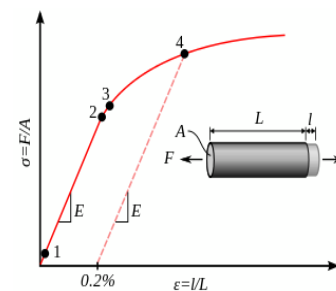
Medical analogy: The elastic behavior analogy in medicine can be expressed by the metal rod analogy for the postprandial plasma glucose (PPG). Consuming carbohydrates and/or sugar acts like a tensile force to stretch a metal rod longer, while post-meal exercise acts like a compressive force to

suppress a metal rod shorter. If lacking food consumption and exercise, the metal rod (analogy of PPG) will remain its original length, for a non-diabetes or less severe type 2 diabetes (T2D) patient.

Plasticity (physics):

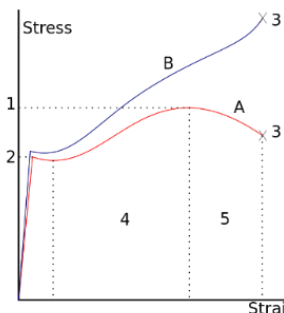
Deformation of a solid material undergoing non-reversible changes of shape in response to applied forces.

In physics and materials science, plasticity, also known as plastic deformation, is the ability of a solid material to undergo permanent deformation, a non-reversible change of shape in response to applied forces. For example, a solid piece of metal being bent or pounded into a new shape displays plasticity as permanent changes occur within the material itself. In engineering, the transition from elastic behavior to plastic behavior is known as yielding. Plastic deformation is observed in most materials, particularly metals, soils, rocks, concrete, and foams.



A stress-strain curve showing typical yield behavior for nonferrous alloys.

1. True elastic limit
2. Proportionality limit
3. Elastic limit
4. Offset yield strength



A stress-strain is typical of structural steel.

- 1: Ultimate strength
- 2: Yield strength (yield point)
- 3: Rupture
- 4: Strain hardening region
- 5: Necking region
- A: Apparent stress (F/A<sub>0</sub>)
- B: Actual stress (F/A)

For many ductile metals, tensile loading applied to a sample will cause it to behave in an elastic manner. Each increment of load is accompanied by a proportional increment in extension. When the load is removed, the piece returns to its original size. However, once the load exceeds a threshold – the yield strength – the extension increases more rapidly than in the elastic region; now when the load is removed, some degree of extension will remain.

Medical analogy: A plastic behavior analogy in medicine is the PPG level of a severe T2D patient. Even consuming a smaller amount of carbs/sugar, the patient’s PPG will rise sharply which cannot be totally brought down to a healthy PPG level even with a significant amount of exercise. This means the PPG level has exceeded its “elastic limit” and entering into a “plastic range”.

Viscoelasticity:

Property of materials with both viscous and elastic characteristics under deformation.

In materials science and continuum mechanics, viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Viscous materials, like water, resist shear flow and strain linearly with time when a stress is applied. Elastic materials strain when stretched and immediately return to their original state once the stress is removed.

Viscoelastic materials have elements of both of these properties and, as such, exhibit time-dependent strain. Whereas elasticity is usually the result of bond stretching along crystallographic planes in an ordered solid, viscosity is the result of the diffusion of atoms or molecules inside an amorphous material.

In the nineteenth century, physicists such as Maxwell, Boltzmann, and Kelvin researched and experimented with creep and recovery of

glasses, metals, and rubbers. Viscoelasticity was further examined in the late twentieth century when synthetic polymers were engineered and used in a variety of applications. Viscoelasticity calculations depend heavily on the viscosity variable,  $\eta$ . The inverse of  $\eta$  is also known as fluidity,  $\phi$ . The value of either can be derived as a function of temperature or as a given value (i.e. for a dashpot).

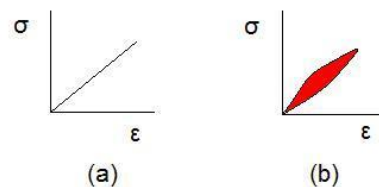
Depending on the change of strain rate versus stress inside a material, the viscosity can be categorized as having a linear, non-linear, or plastic response. In addition, when the stress is independent of this strain rate, the material exhibits plastic deformation. Many viscoelastic materials exhibit rubber-like behaviors explained by the thermodynamic theory of polymer elasticity.

Cracking occurs when the strain is applied quickly and outside of the elastic limit. Ligaments and tendons are viscoelastic, so the extent of the potential damage to them depends both on the rate of the change of their length as well as on the force applied.

A viscoelastic material has the following properties:

- hysteresis is seen in the stress-strain
- stress relaxation occurs: step constant strain causes decreasing stress
- creep occurs: step constant stress causes increasing strain
- its stiffness depends on the strain rate or the stress rate.

Elastic versus viscoelastic behavior:



Stress-strain curves for a purely elastic material (a) and a viscoelastic material (b). The red area is a hysteresis loop and shows the amount of energy lost (as heat) in a loading and unloading cycle. It is equal to  $\oint \sigma d\epsilon$  where  $\sigma$  is stress and  $\epsilon$  is strain. In other words, the hysteresis loop area represents

the amount of energy during the loading and unloading process.

Unlike purely elastic substances, a viscoelastic substance has an elastic component and a viscous component. The viscosity of a viscoelastic substance gives the substance a strain rate dependence on time. Purely elastic materials do not dissipate energy (heat) when a load is applied, then removed. However, a viscoelastic substance dissipates energy when a load is applied, then removed. Hysteresis is observed in the stress-strain curve, with the area of the loop being equal to the energy lost during the loading cycle. Since viscosity is the resistance to thermally activated plastic deformation, a viscous material will lose energy through a loading cycle. Plastic deformation results in lost energy, which is uncharacteristic of a purely elastic material's reaction to a loading cycle.

Viscoplasticity:

Viscoplasticity is a theory in continuum mechanics that describes the rate-dependent inelastic behavior of solids. Rate-dependence in this context means that the deformation of the material depends on the rate at which loads are applied. The inelastic behavior that is the subject of viscoplasticity is plastic deformation which means that the material undergoes unrecoverable deformations when a load level is reached. Rate-dependent plasticity is important for transient plasticity calculations. The main difference between rate-independent plastic and viscoplastic material models is that the latter exhibit not only permanent deformations after the application of loads but continue to undergo a creep flow as a function of time under the influence of the applied load.

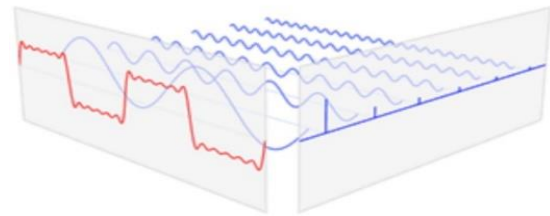
Medical analogy: In viscoelastic or viscoplastic analysis, the stress component equals the strain change rate of time multiplying with the viscosity factor, or

$$\begin{aligned} \text{Stress } (\sigma) & \\ &= \text{strain } (\epsilon) \text{ change rate} * \text{viscosity factor } (\eta) \\ &= d\epsilon/dt * \eta \end{aligned}$$

$$\begin{aligned} \text{The hysteresis loop area} & \\ &= \text{the integrated area of stress } (\sigma) \text{ and strain} \\ &(\epsilon) \text{ curve} \\ &= \oint \sigma d\epsilon \end{aligned}$$

## 2.2 From time-domain to frequency domain via Fourier transform

In physics, electronics, control systems engineering, and statistics, the frequency domain refers to the analysis of mathematical functions or signals concerning frequency, rather than time.[1] Put simply, a time-domain graph shows how a signal changes over time, whereas a frequency-domain graph shows how much of the signal lies within each given frequency band over a range of frequencies. A frequency-domain representation can also include information on the phase shift that must be applied to each sinusoid to be able to recombine the frequency components to recover the original time signal.



The Fourier transform converts the function's time-domain representation, shown in red, to the function's frequency-domain representation, shown in blue. The component frequencies, spread across the frequency spectrum, are represented as peaks in the frequency domain.

A given function or signal can be converted between the time and frequency domains with a pair of mathematical operators called transforms. An example is the Fourier transform, which converts a time function into a complex-valued sum or integral of sine waves of different frequencies, with amplitudes and phases, each of which represents a frequency component. The "spectrum" of frequency components is the frequency-domain representation of the signal. The inverse Fourier transform converts the frequency-domain function back to the time-domain function. A spectrum analyzer is a tool commonly used to visualize electronic signals in the frequency domain.

Advantages

One of the main reasons for using a frequency-domain representation of a problem is to simplify the mathematical

analysis. For mathematical systems governed by linear differential equations, a very important class of systems with many real-world applications, converting the description of the system from the time domain to a frequency domain converts the differential equations to algebraic equations, which are much easier to solve.

In addition, looking at a system from the point of view of frequency can often give an intuitive understanding of the qualitative behavior of the system, and a revealing scientific nomenclature has grown up to describe it, characterizing the behavior of physical systems to time-varying inputs using terms such as bandwidth, frequency response, gain, phase shift, resonant frequencies, time constant, resonance width, damping factor, Q factor, harmonics, spectrum, power spectral density, eigenvalues, poles, and zeros.

An example of a field in which frequency-domain analysis gives a better understanding than the time domain is music; the theory of operation of musical instruments and the musical notation used to record and discuss pieces of music is implicitly based on the breaking down of complex sounds into their separate component frequencies (musical notes).

#### Magnitude and phase

In using the Laplace, Z-, or Fourier transforms, a signal is described by a complex function of frequency: the component of the signal at any given frequency is given by a complex number. The modulus of the number is the amplitude of that component, and the argument is the relative phase of the wave. For example, using the Fourier transform, a sound wave, such as human speech, can be broken down into its component tones of different frequencies, each represented by a sine wave of different amplitude and phase. The response of a system, as a function of frequency, can also be described by a complex function. In many applications, phase information is not important. By discarding the phase information, it is possible to simplify the information in a frequency-domain representation to generate a frequency spectrum or spectral density. A spectrum analyzer is a device that displays the spectrum, while the time-domain signal can be seen on an oscilloscope.

#### Types

Although "the" frequency domain is spoken of in the singular, there are several different mathematical transforms that are used to analyze time-domain functions and are referred to as "frequency domain" methods. These are the most common transforms and the fields in which they are used:

- Fourier series – periodic signals, oscillating systems.
- Fourier transform – aperiodic signals, transients.
- Laplace transform – electronic circuits and control systems.
- Z transform – discrete-time signals, digital signal processing.
- Wavelet transform — image analysis, data compression.

More generally, one can speak of the transform domain for any transform. The above transforms can be interpreted as capturing some form of frequency, and hence the transform domain is referred to as a frequency domain.

#### Discrete frequency domain

The Fourier transform of a periodic signal has energy only at a base frequency and its harmonics. Another way of saying this is that a periodic signal can be analyzed using a discrete frequency domain. Dually, a discrete-time signal gives rise to a periodic frequency spectrum. Combining these two, if we start with a time signal which is both discrete and periodic, we get a frequency spectrum which is also both discrete and periodic. This is the usual context for a discrete Fourier transform.

#### History of term

The use of the terms "frequency domain" and "time domain" arose in communication engineering in the 1950s and early 1960s, with "frequency domain" appearing in 1953. See time domain: the origin of the term for details.

**Note:** For a more detailed description, please refer to the "consolidated method" section which is given at the beginning of the special issue.

### 3. RESULTS

Figure 1 shows the questionnaire of the MI model and sample data of psychological symptoms.

The screenshot shows two columns of input fields for 'Psychological Stimulators' (M1-M10) and 'Psychological Symptoms' (M1-M10). Below the inputs are 'Calculate' buttons. At the bottom, the calculated MI values are shown: MI=0.0600 for the normal case and MI=1.6000 for the BPD case.

Figure 1: Stimulations and symptoms of BPD and sample data.

Figure 2 displays the data table of this analysis.

7/4/22	Normal	Viscosity	Strain Rate	Strain	Stress	Height	Area	Strain*Stress	Strain*Stress %
Psychology	Symptoms	Stimulator	Symp Rate	Symptoms	Stimulator				
Y20Q1	1	0.19	0.0	1	0.0	0.00	0.00	0.00	0.0
Y20Q2	3	0.19	2.4	3	0.5	0.23	0.55	1.6	
Y20Q3	5	0.18	1.6	5	0.3	0.37	0.60	1.4	
Y20Q4	7	0.18	2.0	7	0.4	0.32	0.65	2.5	
Y21Q1	8	0.16	1.0	8	0.2	0.26	0.26	1.3	
Y21Q2	10	0.15	2.0	10	0.3	0.23	0.46	3.0	
Y21Q3	7	0.14	-3.0	7	-0.4	-0.06	0.18	-2.9	
Y21Q4	8	0.15	-1.0	6	-0.2	-0.29	0.29	-0.9	
Y22Q1	8	0.15	2.0	8	0.3	0.08	0.15	2.4	
Y22Q2	6	0.14	-2.0	6	-0.3	0.01	-0.02	-1.7	
Average & Sum	6	0.16	0.5	6	0.1	0.1	3.1	6.6	8%
Correlation	100%	-69%	17%			SD Energy %	9%		
TD Energy %	2%	0.03	TD (epsi*eta)	1.00	5%	FD Energy %	0.2%	39	

7/4/22	BPD	Viscosity	Strain Rate	Strain	Stress	Height	Area	Strain*Stress	Strain*Stress %
Psychology	Symptoms	Stimulator	Symp Rate	Symptoms	Stimulator				
Y20Q1	11	0.98	0.0	11	0.0	0.00	0.00	0.00	0.0
Y20Q2	13	1.10	2.0	13	2.2	1.10	2.20	28.6	
Y20Q3	15	1.20	2.0	15	2.4	2.30	4.60	36.0	
Y20Q4	17	1.30	2.0	17	2.6	2.50	5.40	44.2	
Y21Q1	19	1.40	2.0	19	2.8	2.70	5.40	53.2	
Y21Q2	18	1.30	-1.0	18	-1.3	0.75	-0.75	-23.4	
Y21Q3	17	1.20	-1.0	17	-1.2	-1.25	1.25	-20.4	
Y21Q4	20	1.40	3.0	20	4.2	1.50	4.50	84.0	
Y22Q1	16	1.35	-4.0	16	-5.4	-0.60	2.40	-86.4	
Y22Q2	14	1.31	-2.0	14	-2.6	-4.01	8.01	-36.5	
Average & Sum	16	1.25	0.3	16	0.4	0.5	32.6	79.3	92%
Correlation	100%	85%	17%			SD Energy %	91%		
TD Energy %	98%	1.57	TD (epsi*eta)	20.06	95%	FD Energy %	99.8%	25651	

Figure 2: Data table of 3 analyses.

Figure 3 depicts space-domain VGT energy.

Figure 4 reflects frequency-domain FFT energy.

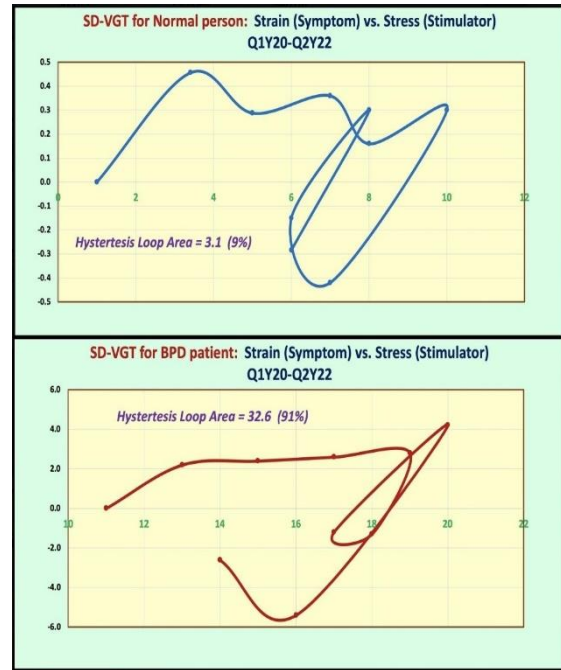


Figure 3: Space-domain VGT energy of both normal and BPD.



Figure 4: Frequency-domain FFT energy of both normal and BPD.

Figure 5 illustrates the comparison of results from TD energy, SD energy, and FD energy for both normal and BPD cases, including the defined variable of (strain\*stress) in TD and FD energy comparison.

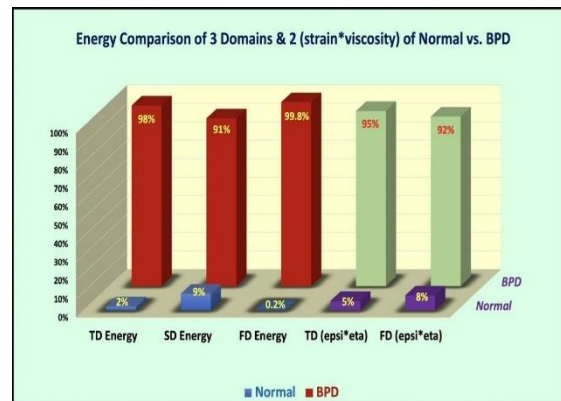


Figure 5: Comparison of TD (PPG square), SD energy, and FD energy and defined new variable of (symptom\*stimulation) energy analysis.

## 4. CONCLUSION

In summary, there are 5 observations as follows:

- (1) From the TD energy analysis results using the squared symptom value as an indication of energy level, the TD energy for normal versus BPD is normal = 2% versus BPD = 98%. The TD energy ratio is 49:1.
- (2) From the SD energy analysis results using the hysteresis loop area as an indication of energy level, the SD energy for normal versus BPD is normal = 9% versus BPD = 91%. The SD energy ratio is 10:1.
- (3) Further detailed examination of the space domains stress values (stimulator) versus its strain values (symptoms), Normal case and BPD cases have two different curve patterns where both show viscoplastic behaviors, e.g. time-dependency, non-convergence between the initial period data, and ending period data. There is a gap between the starting point and ending point, and the existence of hysteresis loops (energy generation or loss through the loading and unloading process of stimulations). Like watching a movie, the two SD-VGT stress-strain curves show how the two individuals are coping with the COVID pandemic within the same period. The data range of the x-axis (symptom-axis) and y-axis (stimulation-axis) for the normal person is much smaller than for the BPD patient which means the COVID pandemic has induced higher psychological and emotional impacts on the BPD patient than the normal person.
- (4) From the FD energy analysis results using the frequency curve area as an indication of energy level, the FD energy for normal versus BPD is normal = 0.2% versus BPD = 99.8%. The FD energy ratio is 499:1.
- (5) An interesting finding from the additional 2 analyses using the newly defined variable of (strain\*stress) or (symptom\*stimulation) have demonstrated the TD energies are normal = 5% versus BPD = 95% with an energy ratio of 19:1, and the FD energies are normal = 8% versus BPD = 92% with an energy ratio of 12:1.

In conclusion, whichever energy analysis tools are being utilized, the BPD patient's energy is more than 10 times higher than the

normal person's energy (actually, 10x, 12x, 19x, 49x, 499x). From the perspective of physics and mathematics, the energy is generated by input multiplying with output, a "double amplification effect" which causes a much higher value than the original value of either input or output alone. From the viewpoint of psychology and medicine, if the medical doctor or psychotherapist observes one biomarker or symptom, they can see the fluctuations of this original variable to make a judgment on the patient's condition. However, if they can explore the "energy associated with either symptom/stimulation or output biomarker/input biomarker", they would reveal more and deeper information regarding the patient's complex condition. For example, from this particular study, the BPD patient has generated and carried at least 10 times or more burden than the normal person during the COVID pandemic.

People with personality disorders (at least 14 different PD types have been identified) and certain psychological diseases are living their daily lives with additional internal burdens. The pandemic situation only makes their situation worse. PD, including BPD, is similar to diabetes which can only be controlled or improved, but nearly impossible, or at least extremely difficult to be removed or cured. The extra burden on their minds is the "energy" discussed in this article.

BPD emotional control is a complex and problematic task in addition to the individual domain-know-how of medicine and psychology fields. The complex biophysical behaviors of multi-phased psychological BPD behaviors require a deeper and thorough knowledge of physics, engineering, and mathematics, instead of depending only on the traditional way of biology, chemistry, and statistics.

The BPD data pattern case is indeed following the natural law of physics, which is similar to the diabetes data pattern case - the author's specialty of medical research. From this study, we can also see that physics theory and engineering modeling are suitable tools for conducting psychological research work, except for the task of collecting ample clinical data from patients and psychotherapists.

## **5. ACKNOWLEDGMENT**

Without Professor Norman Jones at MIT as his academic advisor, the author would not be able to conduct this particular research work and published nearly 700 medical research papers. The author has never forgotten his advice to him that he should always focus on and enhance his basic strength in foundations, such as mathematics and physics, to make further improvements and advancements. Professor Jones has also provided him with a personal example of doing outstanding teaching and research job with an excellent work attitude, extreme dedication, and ultimate commitment to advancing both science and engineering.

## **6. REFERENCES**

For editing purposes, the majority of the references in this paper, which are self-references, have been removed for this article. Only references from other authors' published sources remain. The bibliography of the author's original self-references can be viewed at [www.eclairemd.com](http://www.eclairemd.com).

To read additional published VGT analyses on medical research, please view them in the following three journals:

- (1) Special Issue. The GH-Method. (<https://www.theghmethod.com>)
- (2) Journal of Applied Material Science & Engineering Research (contact: Catherine)
- (3) Advances in Bioengineering and Biomedical Science Research (contact: Sonny Hazi).

# Viscoelastic and Viscoplastic Glucose Theory Application in Medicine

Gerald C. Hsu

