

# An Abnormal Psychology Study Using Stressors and Symptoms for a Hypothetical Individual with Borderline Personality Disorder and a Comparison with the Physio-Pathology Study Using Lifestyle Details and Glucoses from an Individual with Type 2 Diabetes by Applying the Concepts from Viscoelastic and Viscoplastic Glucose Theory (VGT #12) Based on GH-Method: Math-Physical Medicine (No. 591)

Gerald C Hsu

eclairMD Foundation, USA

\*Corresponding author

Gerald C Hsu, eclairMD Foundation, USA

Submitted: 16 Nov 2022; Accepted: 23 Nov 2022; Published: 30 Nov 2022

**Citations:** Hsu, G. C. (2022). An Abnormal Psychology Study Using Stressors and Symptoms for a Hypothetical Individual with Borderline Personality Disorder and a Comparison with the Physio-Pathology Study Using Lifestyle Details and Glucoses from an Individual with Type 2 Diabetes by Applying the Concepts from Viscoelastic and Viscoplastic Glucose Theory (VGT #12) Based on GH-Method: Math-Physical Medicine (No. 591). *J Edu Psyc Res*, 4(3), 533-543.

## Abstract

The majority of this article focuses on stressors and symptoms of a hypothetical patient with borderline personality disorder (BPD) during the period from Y2010 to Y2022. The example cited is a purely hypothetical patient with BPD conditions. The author has accumulated knowledge on abnormal psychology since 2002 and augmented it from his established five psychotherapy centers to care for approximately 200 abused women and abandoned children from 2006 to 2010. Due to confidentiality, he cannot reveal any of their identities, but their general stories or commonly observed behaviors have been included in the hypothetical BPD case.

Psychology is an empirical science and, at times, it is easier to describe in words stressors (root causes), symptoms, behaviors, reactions, and/or treatments; however, it is more difficult to describe them in numbers, a quantitative manner, even though most psychological research works are based on statistics only, but not based on any branches of natural science. The author self-studied, observed, and managed abnormal psychology therapy for 9-years, from 2002 to 2010. He has read approximately 100 textbooks and 500+ clinical reports during that period. Based on his findings, he tried to develop some "scientific" formula-based equations with a quantitation and precision approach to study and research abnormal psychology. Here, the word "scientific" means observing physical phenomena, applying physics principles, deriving mathematical equations, building engineering modeling, and utilizing computer and artificial intelligence tools - not applying statistics tools alone. Since 2010, it has been difficult to collect and utilize data from patients with Personality Disorder (PD) without breaching professional ethics and patient confidentiality. The author has given up his original idea of using the developed math-physical medicine research approach (MPM) for the psychology field. In the summer of 2010, when his health conditions became life-threatening due to severe type 2 diabetes (T2D) complications, he launched his GH-Method: math-Physical medicine (MPM) research approach on metabolism, endocrinology, and food nutrition to save his own life. To date, he has written and published nearly 600 medical papers using the MPM method. This particular paper is one of his few attempts to apply his developed MPM methodology to the abnormal psychology field of BPD. The author hopes to continue his psychological research by using more of the MPM approach. He appreciates the invaluable inputs, comments, criticisms, and suggestions from his colleagues regarding the area of abnormal psychology.

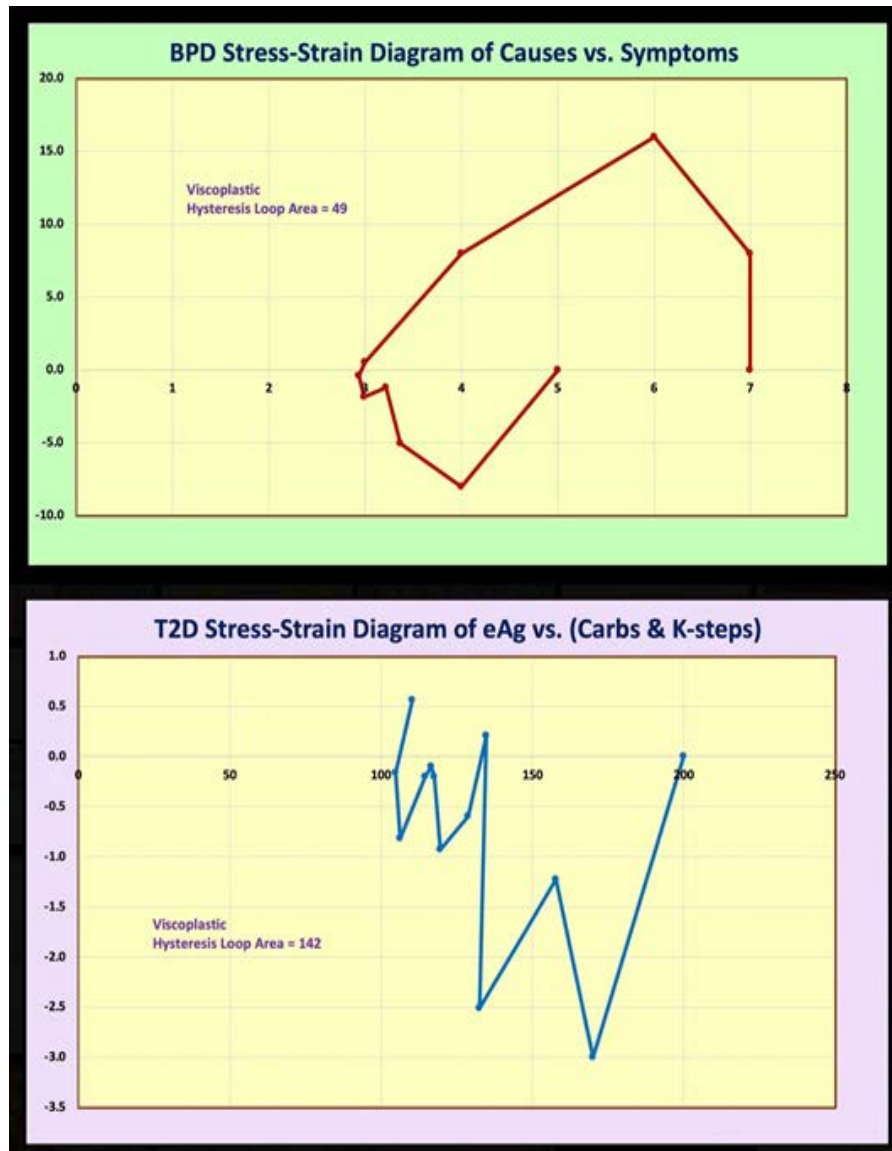
In summary, although this article mainly focused on a psychological case study with hypothetical data from any BPD patient, it was also complemented with a physio-pathological case study with the collected data of an actual T2D patient.

When the author displays the two case results together using a space diagram (SD) of stress (causes) versus strain (symptoms), these two case results have demonstrated an observed viscoplastic behavior, e.g. time-dependency, non-convergence between the initial period data and ending period data, and hysteresis loops (energy loss through loading and unloading process). **By using descriptive psychology language, it can illustrate the viscoplastic BPD behavior that their stressors and symptoms are changing from time to time which does not have the same pattern at the initial and ending states of a selected period. Furthermore, this up-and-down or loading-and-unloading cycle creates a loss of energy for the BPD patient, while coping with this disorder.**

This means that the BPD psychological data pattern follows the natural physics law which is similar to the T2D data pattern. Therefore, the engineering theories and models of elasticity, plasticity, viscoelasticity, viscoplasticity, and energy may be suitable tools for the author's future investigations of human psychological behaviors.

It should be noted that the BPD psychological case with simplified hypothetical data is different from the T2D physiological case with the collected real data. The two datasets have different scales which cause varying hysteresis loop area sizes; therefore, it makes no sense to compare the sizes.

To examine the details of both glucoses of T2D and symptoms of BPD, we notice that the T2D patient's glucose improves while the BPD patient's symptoms become worse. **The isolated peaceful and non-traveling lifestyle has contributed to better glucoses for the T2D patient, but the fear and loneliness associated with the COVID-19 pandemic and its quarantine lifestyle contribute to the symptoms of BPD.**



---

## Introduction

The majority of this article focuses on stressors and symptoms of a hypothetical patient with borderline personality disorder (BPD) during the period from Y2010 to Y2022. The example cited is a purely hypothetical patient with BPD conditions. The author has accumulated knowledge on abnormal psychology since 2002 and augmented it from his established five psychotherapy centers to care for approximately 200 abused women and abandoned children from 2006 to 2010. Due to confidentiality, he cannot reveal any of their identities, but their general stories or commonly observed behaviors have been included in the hypothetical BPD case.

Psychology is an empirical science and, at times, it is easier to describe in words stressors (root causes), symptoms, behaviors, reactions, and/or treatments; however, it is more difficult to describe them in numbers, a quantitative manner, even though most psychological research works are based on statistics only, but not based on any branches of natural science. The author self-studied, observed, and managed abnormal psychology therapy for 9-years, from 2002 to 2010. He has read approximately 100 textbooks and 500+ clinical reports during that period. Based on his findings, he tried to develop some “scientific” formula-based equations with a quantitation and precision approach to study and research abnormal psychology. Here, the word “scientific” means observing physical phenomena, applying physics principles, deriving mathematical equations, building engineering modeling, and utilizing computer and artificial intelligence tools - not applying statistics tools alone. Since 2010, it has been difficult to collect and utilize data from patients with Personality Disorder (PD) without breaching professional ethics and patient confidentiality. The author has given up his original idea of using the developed math-physical medicine research approach (MPM) for the psychology field. In the summer of 2010, when his health conditions became life-threatening due to severe type 2 diabetes (T2D) complications, he launched his GH-Method: math-Physical medicine (MPM) research approach on metabolism, endocrinology, and food nutrition to save his own life. To date, he has written and published nearly 600 medical papers using the MPM method. This particular paper is one of his few attempts to apply his developed MPM methodology of the abnormal psychology field of BPD. *The author hopes to continue his psychological research by using more of the MPM approach. He appreciates the invaluable inputs, comments, criticisms, and suggestions from his colleagues regarding the area of abnormal psychology.*

## Methods

### Borderline Personality Disorder

Here, the author will discuss BPD stressors such as root causes and stimulators along with the behavioral symptoms which include outputs, diagnosis, and treatment.

Personality disorder (PD) is defined as an enduring pattern of thinking, feeling, and behavior that is relatively difficult to change over time. As one of the 15 disorders, PD has 11 additional detailed categories that include borderline personality disorder (BPD).

BPD is a mental illness with a pervasive pattern of instability within interpersonal relationships, self-image and affects, and marked impulsiveness that could begin in early adulthood and presents itself in a variety of contexts. The author has self-studied this subject for 9-years and performed clinical research on his 200 psychological patients, where he utilized the information from DSM-IV: Diagnostic and Statistical Manual of Mental Disorders (Reference 1), which is widely used by many psychologists and psychotherapists in the world. As a result, he can provide some general guidelines regarding his developed mental index mathematical model.

Here are the ten stressors for BPD, including the original root causes and stimulators or symptoms:

- (1) Parents (including both parental separation or parental loss during young adult or adolescent years): This stressor relates to the “abandonment” experiences and even some types of parental abuse.
- (2) Abuse (including physical, verbal, emotional, and sexual abuse during young adult or adolescent years): Emotional abuse can include neglect, abandonment, or verbal cruelty. At times, verbal abuse can be worse than physical abuse because verbal abuse can destroy a young person’s self-identity, self-image, self-value, and self-confidence. Love can hurt means that some parents actually abuse their children under the pretense of “love” (Reference 2, Toxic Parents).
- (3) Family situation (specifically, many first-degree biological relatives who also suffer from similar psychological stress): The individual may have a 5 times higher chance to develop a form of PD. Usually, it is easier to identify other forms of PD among siblings. Children who grow up in a dysfunctional family together would suffer similar unpleasant experiences which lead to a variety of PD types. For example, we can find a sister that has borderline PD, while her brother has antisocial PD. Family members who have experienced abuse, neglect, and/or hostile conflicts are more likely to turn into BPD or another type of PD patient.
- (4) Gender (affecting females more): usually, females account for about 75% of BPD cases while males account for only 25%. In the general population, there are approximately 2% of BPD cases, makeup about 30% to 60% of all PD patients. As a result, BPD is the largest group.
- (5) Flashback: this stressor and behavioral symptom results from terrible experiences in early life and serves as a stimulator or stressor for a BPD patient’s later recurrence of behaviors. When a patient has flashbacks of a past memory or scene, his or her following acts, moods, and behaviors will suddenly become “abnormal”. It is like a “bad dream” that will not go away.
- (6) Polarized view: BPD patients tend to see the world in a polarized way, in one extreme or another. Everything and everyone become either black or white, good or evil, where this view can switch quickly. A BPD patient cannot view things in this world as a shade of gray like most normal people. The root cause will relate to other behaviors affecting interpersonal relationships, such as anger, panic, depression, despair, and mood swings.
- (7) Interpersonal Relationships: it means unstable and intense interpersonal relationships. BPD patients will either see other people as an angel, caregiver, or best friend, and then can

suddenly see the same people as evil, destroyer, or worst enemy. When having a relationship, their emotional expressions are usually extremely fierce and intense; however, when they change their views, their hate will be equally strong and bitter. This type of behavior would cause deeper damage to themselves resulting in unstable emotions.

(8) Difficulties in life: many BPD patients have trouble dealing with the difficulties in their lives, including education, career, job, social life, relationships with their spouse and children. Many of them have complications with finishing their education, creating a stable work life, being a long-term friend, or keeping a marriage.

(9) Abandonment experiences: this abandonment experience in young adults or adolescence will likely stay with the BPD patient as a lifelong stressor. Many of their behavioral symptoms are centered around this “abandonment” issue. Their resulting action is more violent caused by flashbacks from the *fear of abandonment* in their early life.

(10) Special stimuli: Everyone will face or experience some special stimuli in their life, but BPD patients do not have sufficient abilities to cope with these surprises or difficulties. They will react differently and often more strongly when encountering stimuli, such as the COVID-19 epidemic. As a result, sometimes they have combined complex reactive behaviors almost like a “chain reaction”. For example, the COVID-19 quarantine period decreased social interactions, limiting school-aged children from attending class and outdoor activities. Therefore, this child's frustration causes a self-image of poor parenting, increasing the patient's depression or even anger, and then affecting other family members, where this whole process is a “chain effect” or a “nuclear reaction” process.

Next, the author will cover ten major behavioral symptoms of BPD patients. The information is from the academic knowledge he has obtained from reading nearly 100 textbooks and 500+ clinical reports over the past 19 years, including the DSM-IV, with the combination of his 5 years of clinical experience and knowledge from managing five psychotherapy centers assisting 200 patients. Some of these described behavioral symptoms may change over time and with age. Patients in their 30s and 40s may have greater stability in their relationships and vocational functioning. After approximately 10 years, approximately 50% of patients may no longer exhibit a pattern of behavior that meets the full criteria for BPD.

(1) Fear of abandonment: As described previously, this is one of the major causes and behavioral symptoms of BPD. It also connects with many other behaviors, such as intense interpersonal relationships, poor self-image, extreme emptiness and loneliness, and fear of separation or rejection. They will make frantic efforts to avoid real or imagined “abandonment”.

(2) Unstable or intense interpersonal relationships: BPD patients treat their interpersonal relationships with a much stronger, intense, or sometimes with intimidation. They have strong positive emotions with their friends, lovers, or life partners, and with equally strong hate and negative emotions when separated. Sometimes, a separation may even trigger a suicidal attempt. This behavior also relates to other impulsive acts and the “black and white” polarized views toward the world. Some BPD pa-

tients even have the same behavior toward their sex life and become promiscuous. This relationship instability will cause more and deeper harm to themselves and the people around them.

(3) Identify and self-image disturbance: Sometimes, the perception of impending separation or rejection, or the loss of external structure, can lead to profound changes in self-image, affect, cognition, and behavior. Even an environmental change due to unique stimuli, such as Covid-19, can alter their self-image. Due to the abuse or emotional damage when younger, they might lose some of their judgment ability between an objective external environment versus their internal self-image, value, and identity. This identity disturbance can cause them to shift goals and values associated with career, education, change opinions and life plans, and even drop friends.

(4) Impulsiveness: A BPD patient may possess at least two types of the self-damaging impulsive areas, including over-spending, shopping sprees, gambling, promiscuity, substance abuse, reckless driving, or binge eating. Not every BPD patient would have this impulsiveness. However, if someone has two or more of these behaviors, there is a high probability this person would be a severe BPD patient.

(5) Suicidal behavior or self-mutilating: Usually, some BPD patients would have recurrent suicidal attempts or self-mutilating behaviors. The main message they are trying to send to others is seeking help. Their recurring suicidal attempts are indeed their inner cry for help. Through self-mutilation, they actually feel some degree of satisfaction or relief, and strangely prove their life existence. Nevertheless, these two acts are horrifying and dangerous. About 8% to 10% of suicide attempts are successful. The risk of suicide and self-mutilation occur mostly in young adults but may stretch into their early 30s, and then gradually decrease as they get older; unfortunately, many other BPD behaviors may be lifelong.

(6) Mood swings: Mood swings usually last a few hours and rarely more than a few days. For most BPD patients, their mood swings will continue throughout their lifetime. These types of rapid emotional changes actually hurt the person who cares about the patient the most. Their loved ones usually live a kind of life similar to “walking on eggshells” (Reference 3). ***The BPD patient's behavior causes stress on their spouse and/or children who may develop many different kinds of chronic diseases, such as obesity or diabetes. This linkage demonstrates the relationship between BPD and T2D.*** Sometimes, BPD patients' loved ones may take their frustration out on a third party within the family, such as the children. This is how and why “dysfunctional families” are formed. The mood swings can be combined with impulsiveness along with polarized black-and-white views. They may switch quickly from idealizing others, feeling that the other person is the best lover, friend, or caretaker, into devaluing them, and feeling that the other person does not care enough. In other words, they are prone to sudden and dramatic shifts in their views of others, from “caring” to “rejection”. The typical mood swings are often combined with anger, panic, or despair which can eventually damage the patient's physical health.

(7) Emptiness and Loneliness: This chronic feeling of emptiness inside exists in many BPD patients. In some cases, this emptiness and loneliness could lead to dangerous suicide attempts. They are easily bored and constantly seeking something to do. Some patients are frequently performing laundry or sanitiza-

tion tasks. But this act should be distinguished from an obsessive-compulsive personality disorder (OCPD).

(8) Uncontrollable anger, panic, or despair: They frequently express inappropriate and intense anger, or have difficulty controlling their anger. Some patients may display extreme sarcasm, enduring bitterness, or verbal outbursts. However, their expressions of anger are often followed by shame and guilt. These types of cycles are associated with unstable and intense relationships, polarized black-and-white views, poor self-image, and fear of abandonment or rejection. Combining this anger and mood swings, they often end up with poor performance in school, work, and/or marriage, which leads to dropping out of school, job loss, and/or divorce.

(9) Paranoid Ideation or Severe Dissociation: During periods of extreme stress, transient paranoid ideation or dissociative symptoms (e.g., depersonalization) may occur to protect their inner self. This type of “abnormal self-protection mechanism” usually lasts several minutes or several hours in extreme cases.

(10) Fear of separation or rejection: A small incident could trigger a BPD patient’s strong internal fear of separation, rejection, and sometimes, followed by fear of abandonment. They would frantically try to salvage the situation they created in the first place. Meanwhile, all types of inner fears and confusions will also hit the patient. The combined feelings of anger, panic, loss, and despair will be mixed together. You can imagine how hard it is for a BPD patient to cope with this situation even though the patient may be the person who created this chaos in the first place. Sometimes, the separation or rejection is not even real, but the emotional confusion and hurt feel real to the BPD patient.

### **GH-Method: Math-Physical Medicine (MPM) Methodology**

The description below explains the “GH-Method: math-physical medicine” (MPM) research methodology developed by the author for his biomedical research.

Any system, whether political, economic, engineering, biological, chemical, or even psychological has causes or triggers (inputs) and consequences (outputs). There are definitely some existing connections between inputs and outputs that can be either simple or complicated. The inputs and outputs of any type of system, whether psychological, biological, or chemical, can be observed visually or measured by certain instruments. These physically observed phenomena, including features, images, incidents, or numbers, are merely the “physical expression” of these underneath system structures (e.g. human organ stands for biomedical system/state, human brain stands for mental system/state, or steel plate stands for structural engineering system/state). Once we collect these physical phenomena readings (external expression, similar to a behavior, symptom, or response), either incident, image, or data, we should be able to re-organize or categorize them logically. When we check or analyze the physical phenomena output and cannot figure out why they act or behave according to a certain way (internal causes, reasons, or stressors), we can come up with some guesses or formulate some hypotheses based on some basic principles, theories, or concepts from physics. At this point, we just cannot pull out an equation from a physics textbook and insert it like a “plug-and-play” game. An equation is an expression of a concept or a theory, which is usually associated with some existing conditions,

either initial or boundary. On the contrary, the biomedical or psychological system usually has different types of conditions from other systems. After understanding the meaning of certain observed physical phenomena, the next step is to prove the hypothesis, guess, or interpretation of the phenomenon is correct or incorrect. A solid understanding of mathematics becomes extremely useful to develop a meaningful model which could represent your observed physical phenomena and create certain hypotheses. Engineering modeling techniques and computer science tools, including software, artificial intelligence, and/or big data analytics can offer great assistance in the verification of analysis results from these mathematical operations. If the mathematical results cannot support the hypothesis, then a new hypothesis needs to be formulated. If this new hypothesis is proven to be correct, then we can extend or convert this hypothesis into a mathematical equation or a simpler formula for others to adopt this easier way of thinking and understanding the results. In the final stage, the mathematical equation or formula will be able to “predict” future outcomes based on different sets of input. The author has spent 22 years of self-studying and researching both psychology and endocrinology. Some of his research results must be expressed in a “super simple formula” for patients to comprehend and follow.

For example, *in this article, his “T2D viscosity factor “ $\eta$ ”, is expressed as follows:*

*Viscosity factor, eta “ $\eta$ ” = (carbs/sugar grams \* 2) - (post-meal walking steps in thousand \* 4)*

### **Elasticity, Plasticity, Viscoelasticity, and Viscoplasticity**

#### **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 to them. When the forces are removed, the object will return to its initial shape and size if the material is elastic.

#### **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, 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.

## Elastic Behavior Versus Viscoelastic Behavior

The difference between elastic materials and viscoelastic materials is that viscoelastic materials have a viscosity factor and 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.

*The Following Brief Introductions are Excerpts from Wikipedia*

### Elasticity (Physics)

Physical property when materials or objects return to 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.

The physical reasons for elastic behavior can be quite different for different materials. In metals, the atomic lattice changes size and shape when forces are applied (energy is added to the system). When forces are removed, the lattice goes back to the original lower energy state. For rubbers and other polymers, elasticity is caused by the stretching of polymer chains when forces are applied.

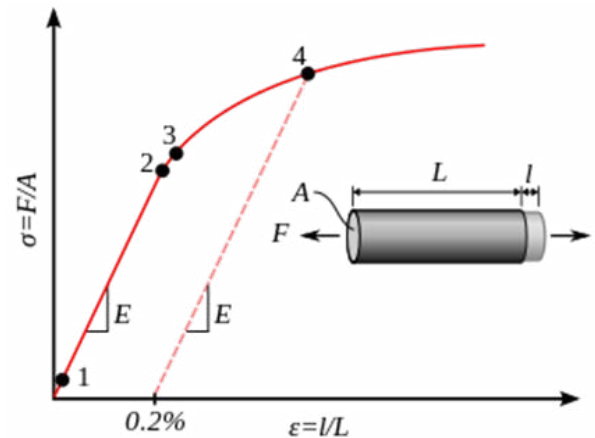
Hooke's law states that the force required to deform elastic objects should be directly proportional to the distance of deformation, regardless of how large that distance becomes. This is known as perfect elasticity, in which a given object will return to its original shape no matter how strongly it is deformed. This is an ideal concept only; most materials which 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.

### Plasticity (Physics)

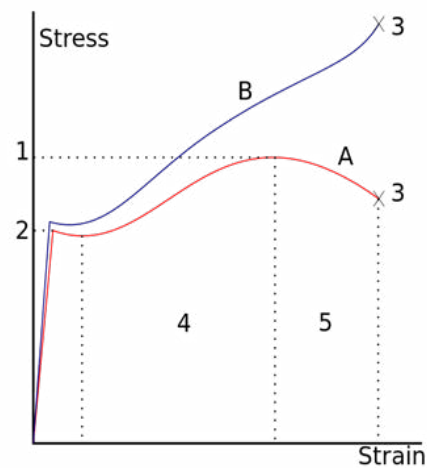
Deformation of a solid material undergoing non-reversible changes of shape in response to applied forces.

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.



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 curve typical of structural steel.

- 1: Ultimate strength
- 2: Yield strength (yield point)
- 3: Rupture
- 4: Strain hardening region
- 5: Necking region
- A: Apparent stress ( $F/A_0$ )
- B: Actual stress ( $F/A$ )

Plastic deformation is observed in most materials, particularly metals, soils, rocks, concrete, and foams. However, the physical mechanisms that cause plastic deformation can vary widely. At a crystalline scale, plasticity in metals is usually a consequence of dislocations. Such defects are relatively rare in most crystalline materials, but are numerous in some and part of their crystal structure; in such cases, plastic crystallinity can result. In brittle materials such as rock, concrete and bone, plasticity is caused predominantly by slip at microcracks. In cellular materials such as liquid foams or biological tissues, plasticity is mainly a consequence of bubble or cell rearrangements, notably TI processes.

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.

Elastic deformation, however, is an approximation and its quality depend on the time frame considered and loading speed. If, as indicated in the graph opposite, the deformation includes elastic deformation, it is also often referred to as "elasto-plastic deformation" or "elastic-plastic deformation".

Perfect plasticity is a property of materials to undergo irreversible deformation without any increase in stresses or loads. Plastic materials that have been hardened by prior deformation, such as cold forming, may need increasingly higher stresses to deform further. Generally, plastic deformation is also dependent on the deformation speed, i.e. higher stresses usually have to be applied to increase the rate of deformation. Such materials are said to deform visco-plastically."

### 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. When a material exhibits a linear response, it is categorized as a Newtonian material. In this case the stress is linearly proportional to the strain rate. If the material exhibits a non-linear response to the strain rate, it is categorized as Non-Newtonian fluid. There is also an interesting case where the viscosity decreases as the shear/strain rate re-

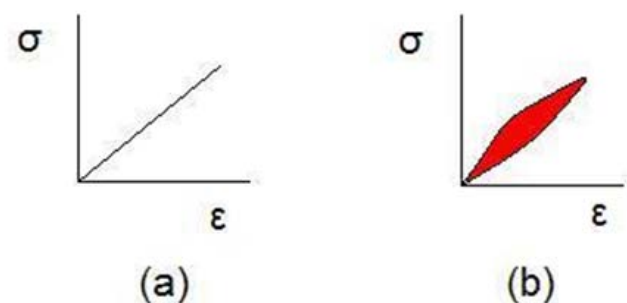
mains constant. A material which exhibits this type of behavior is known as thixotropic. In addition, when the stress is independent of this strain rate, the material exhibits plastic deformation. Many viscoelastic materials exhibit rubber-like behavior explained by the thermodynamic theory of polymer 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 curve
- 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.

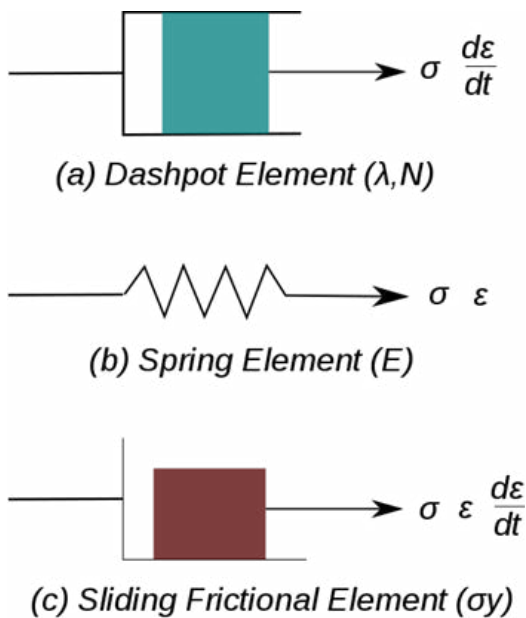
Unlike purely elastic substances, a viscoelastic substance has an elastic component and a viscous component. **The viscosity of a viscoelastic substance gives the substance a strain rate dependent on time.** Purely elastic materials do not dissipate energy (heat) when a load is applied, then removed. 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.

Specifically, viscoelasticity is a molecular rearrangement. When a stress is applied to a viscoelastic material such as a polymer, parts of the long polymer chain change positions. This movement or rearrangement is called "creep". Polymers remain a solid material even when these parts of their chains are rearranging in order to accompany the stress, and as this occurs, it creates a back stress in the material. When the back stress is

the same magnitude as the applied stress, the material no longer creeps. When the original stress is taken away, the accumulated back stresses will cause the polymer to return to its original form. **The material creeps, which gives the prefix visco-, and the material fully recovers, which gives the suffix -elasticity.**

### 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.



**Figure 1:** Elements Used in One-Dimensional Models of Viscoplastic Materials

The elastic response of viscoplastic materials can be represented in one-dimension by Hookean spring elements. Rate-dependence

can be represented by nonlinear dashpot elements in a manner similar to viscoelasticity. Plasticity can be accounted for by adding sliding frictional elements as shown in Figure 1. In the figure  $E$  is the modulus of elasticity,  $\lambda$  is the viscosity parameter and  $N$  is a power-law type parameter that represents non-linear dashpot [ $\sigma(d\epsilon/dt) = \sigma = \lambda(d\epsilon/dt)^{1/N}$ ]. The sliding element can have a yield stress ( $\sigma_y$ ) that is strain rate dependent, or even constant, as shown in Figure 1c.

Viscoplasticity is usually modeled in three-dimensions using overstress models of the Perzyna or Duvaut-Lions types. In these models, the stress is allowed to increase beyond the rate-independent yield surface upon application of a load and then allowed to relax back to the yield surface over time. The yield surface is usually assumed not to be rate-dependent in such models. An alternative approach is to add a strain rate dependence to the yield stress and use the techniques of rate independent plasticity to calculate the response of a material.

For metals and alloys, viscoplasticity is the macroscopic behavior caused by a mechanism linked to the movement of dislocations in grains, with superposed effects of inter-crystalline gliding. The mechanism usually becomes dominant at temperatures greater than approximately one third of the absolute melting temperature. However, certain alloys exhibit viscoplasticity at room temperature (300K). For polymers, wood, and bitumen, the theory of viscoplasticity is required to describe behavior beyond the limit of elasticity or viscoelasticity.

In general, viscoplasticity theories are useful in areas such as

- the calculation of permanent deformations,
- the prediction of the plastic collapse of structures,
- the investigation of stability,
- crash simulations,
- systems exposed to high temperatures such as turbines in engines, e.g. a power plant,
- dynamic problems and systems exposed to high strain rates.

### Phenomenology

For a qualitative analysis, several characteristic tests are performed to describe the phenomenology of viscoplastic materials. Some examples of these tests are

1. hardening tests at constant stress or strain rate,
2. creep tests at constant force, and
3. stress relaxation at constant elongation.



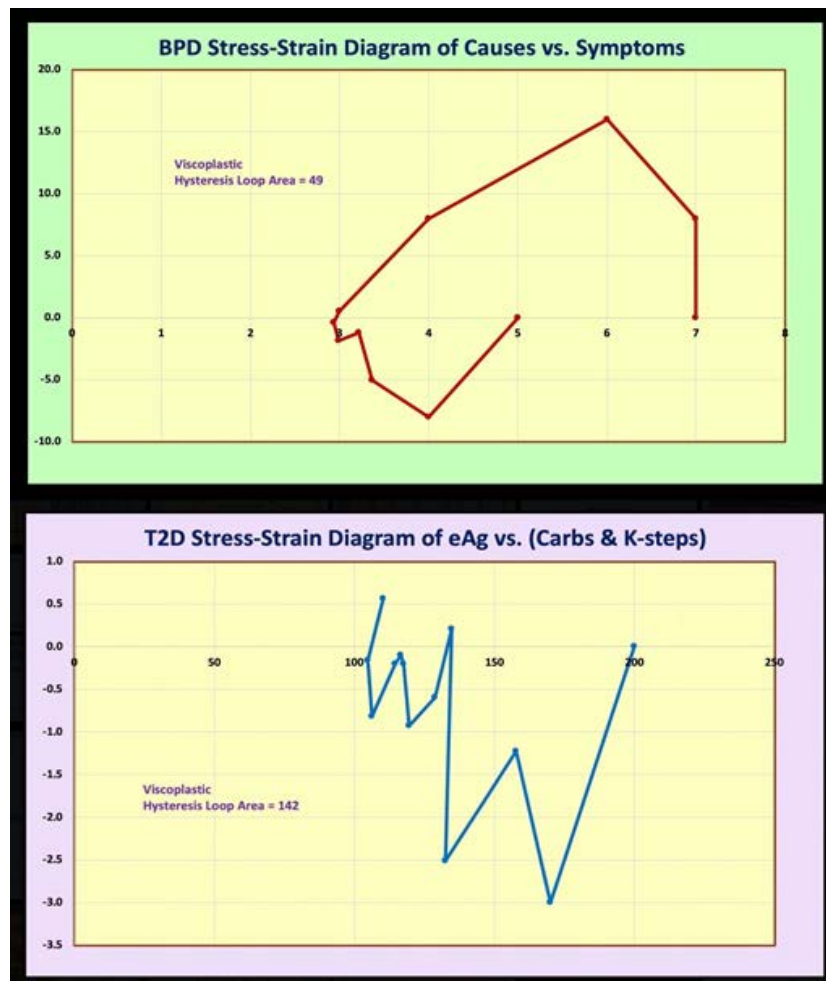
## Results

Figure 2 shows the data table of T2D and BPD cases.

T2D	Strain	Stress	eta			BPD	Strain	Stress	eta
Preiod	Glucose	eta*(de/dt)	Cause	Carbs	K-steps	Preiod	Symptomta*	(de/dt)	Cause
Y2010	200	0.0	194	100	1500	Y2010	5	0.0	10
Y2011	170	-3.0	180	95	2500	Y2011	5	0.0	10
Y2012	158	-1.2	164	88	3000	Y2012	5	0.0	9
Y2013	133	-2.5	130	80	7492	Y2013	4	-8.0	9
Y2014	135	0.2	97	72	11767	Y2014	3	-5.1	8
Y2015	129	-0.6	-31	14.28	14997	Y2015	3	-1.2	8
Y2016	119	-0.9	-37	15.55	17017	Y2016	3	-1.8	7
Y2017	117	-0.2	-42	14.52	17863	Y2017	3	-0.4	7
Y2018	116	-0.1	-42	15.82	18458	Y2018	3	0.5	6
Y2019	114	-0.2	-36	13.24	15742	Y2019	4	8.0	6
Y2020	106	-0.8	-38	13.68	16256	Y2020	6	16.0	7
Y2021	105	-0.2	-33	12.77	14608	Y2021	7	8.0	8
Y2022	110	0.6	-31	13.29	14419	Y2022	7	0.0	9
Average			36			Average			8.0

**Figure 2:** Data Table of Stress, Strain and Viscosity Factor “ $\eta$ ” for Both T2D Case and BPD Case

Figure 3 illustrates the stress (causes) versus strain (symptoms) diagrams for the psychological case (top) and physio-pathological case (bottom).



**Figure 3:** Stress-Strain Diagrams for BOD Case (upper diagram) and T2D Case (lower diagram); Both Appears to be Viscoplastic

Figure 4 depicts the hysteresis loop area calculation for two cases.

T2D	Glucose	eta*(de/dt)	Base a	Base b	(a+B)/2	h	area
Y2010	200	0.0	0.0	-3.0	-1.5	-30.0	44.9
Y2011	170	-3.0	-3.0	-3.0	-3.0	-12.3	36.8
Y2012	158	-1.2	-1.2	-2.5	-1.9	-25.2	47.1
Y2013	133	-2.5	-2.5	0.2	-1.2	2.1	-2.4
Y2014	135	0.2	0.2	-0.6	-0.2	-6.0	1.2
Y2015	129	-0.6	-0.6	-0.9	-0.8	-9.2	7.0
Y2016	119	-0.9	-0.9	-0.2	-0.6	-2.0	1.1
Y2017	117	-0.2	-0.2	-0.1	-0.2	-1.0	0.1
Y2018	116	-0.1	-0.1	-0.2	-0.1	-2.0	0.3
Y2019	114	-0.2	-0.2	-0.8	-0.5	-8.1	4.1
Y2020	106	-0.8	-0.8	-0.2	-0.5	-1.6	0.8
Y2021	105	-0.2	-0.2	0.6	0.2	5.6	1.1
Y2022	110	0.6	0.6	0.0	0.3	-110.3	0.0
<b>Area</b>							<b>142</b>

BPD	Strain	Stress	Base a	Base b	(a+B)/2	h	area
0 min	5	0.0	0.0	0.0	0.0	0.0	0.0
15 min	5	0.0	0.0	0.0	0.0	0.0	0.0
30 min	5	0.0	0.0	-8.0	-4.0	-1.0	4.0
45 min	4	-8.0	-8.0	-5.1	-6.5	-0.6	4.1
60 min	3	-5.1	-5.1	-1.2	-3.1	-0.1	0.5
75 min	3	-1.2	-1.2	-1.8	-1.5	-0.2	0.4
90 min	3	-1.8	-1.8	-0.4	-1.1	-0.1	0.1
105 min	3	-0.4	-0.4	0.5	0.1	0.1	0.0
120 min	3	0.5	0.5	8.0	4.3	1.0	4.3
135 min	4	8.0	8.0	16.0	12.0	2.0	24.0
150 min	6	16.0	16.0	8.0	12.0	1.0	12.0
165 min	7	8.0	8.0	0.0	4.0	0.0	0.0
180 min	7	0.0	0.0	0.0	0.0	-7.0	0.0
<b>Area</b>							<b>49</b>

Figure 4: Area Size Calculations for Both Hysteresis Loops

Figure 5 reflects the score difference before COVID-19 and during COVID-19 for the psychological BPD case.

Item	Stressors (before)	Symptoms (before)	Stressors (during)	Symptoms (during)
M1	1.5	1.5	1.5	1.5
M2	1.5	1.0	1.5	1.5
M3	1.5	1.0	1.5	1.5
M4	1.25	0.5	1.25	0.5
M5	1.5	0.5	1.5	0.5
M6	1.25	1.5	1.25	1.5
M7	1.25	1.0	1.25	1.25
M8	0.5	1.5	1.25	1.5
M9	0.5	0.5	0.5	0.5
M10	0.5	1.5	1.5	1.5

Figure 5: Scores of Both Root Causes (Stressors) and Symptoms (Strains) of BPD Case Prior and During COVID-19

COVID-19 is a horrific and deadly infectious disease. The associated quarantine life not only hurt the global economy but also created a tremendous amount of stress on the individual life, in particular for those people with psychological problems or personality disorders. In this article, the author will address his concerns about a special group of people, BPD patients. Their life in a normal situation is already hard enough for them to cope with, let alone under this tough period. This article will establish one hypothetical BPD patient who is synthesized from other BPD individuals combined with other patients from his previous work.

A more detailed examination of these results reveals some discoveries from both stressors and symptoms. First, this patient's stressors are getting worse due to 2 items: difficulties associated with quarantine and unique stimuli from the virus (fatality, social constraints, and family members' frustrations). Second, this patient's symptoms are worsening due to 3 items: intense interpersonal relationships from quarantine; doubts about self-image due to internal frictions; and feelings of emptiness along with loneliness due to lack of social contact and daily routine disturbance.

Other than the 2 items mentioned in stressors and 3 items in symptoms, additional unspecified items have similar effects for both the "before" and "during" the Covid-19 period.

### Summary

In summary, although this article mainly focused on a psychological case study with hypothetical data from any BPD patient, it was also complemented with a physio-pathological case study with the collected data of an actual T2D patient.

When the author displays the two case results together using a space diagram (SD) of stress (causes) versus strain (symptoms), *these two case results have demonstrated an observed viscoplastic behavior, e.g. time-dependency, non-convergence between the initial period data and ending period data, and hysteresis loops (energy loss through loading and unloading process). By using descriptive psychology language, it can illustrate the viscoplastic BPD behavior that their stressors and symptoms are changing from time to time which does not have the same pattern at the initial and ending states of a selected period. Furthermore, this up-and-down orloading-and-unloading cycle creates a loss of energy for the BPD patient, while coping with this disorder.*

*This means that the BPD psychological data pattern is following the natural physics law which is similar to the T2D data pattern. Therefore, the engineering theories and models of elasticity, plasticity, viscoelasticity, viscoplasticity, and energy may be suitable tools for the author's future investigations of human psychological behaviors.*

It should be noted that the BPD psychological case with simplified hypothetical data is different from the T2D physio-pathological case with the collected real data. *The two datasets have different scales which cause varying hysteresis loop area sizes; therefore, it makes no sense to compare the sizes.*

To examine the details of both glucoses of T2D and symptoms of BPD, we notice that the T2D patient's glucose improves while the BPD patient's symptoms become worse. ***The isolated peaceful and non-traveling lifestyle has contributed to better glucoses for the T2D patient, but the fear and loneliness associated with the COVID-19 pandemic and its quarantine lifestyle contribute to the symptoms of BPD.***

### Reference

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

Readers may use this article as long as the work is properly cited, and their use is educational and not for profit, and the author's original work is not altered.

- (1) Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR), American Psychiatric Association.
- (2) Forward, Susan & Buck, Craig. "Toxic Parents: overcoming their hurtful legacy and reclaiming your life", Amazon book.
- (3) Mason, Paul T. & Krueger, Randi. "Stop walking on eggshells: Taking your life back when someone you care about has Borderline Personality Disorder", third edition, Amazon book.

**Copyright:** ©2022 Gerald C Hsu. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.