

## Using the First-Order Perturbation Equation from Quantum Mechanics to Predict the Postprandial Plasma Glucose Data and Waveforms for Solid and Liquid Egg Meals from a Neuro-Scientific Viewpoint Based on GH-Method: Math-Physical Medicine (No. 470)

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### Abstract

The author has applied the first-order interpolation perturbation equation from quantum mechanics in his medical research work, which he has written numerous articles on this topic. This equation is the simplest application using one selected "perturbation factor" to generate perturbed results with high prediction accuracy.

He investigates this type of problem using a chosen perturbation factor such as carbs/sugar for postprandial plasma glucose (PPG), body weight for fasting plasma glucose (FPG), or metabolism index (MI) in predicting a stroke or heart attack along with achieving longevity in the geriatric research area.

In this particular article, he uses carbs/sugar amount of one large egg as the perturbation factor to predict his perturbed PPG results. The mixed egg meals include the solid and liquid egg data based on two measured PPG waveforms using solid and liquid egg meals, separately.

The two types of egg meals provide different PPG values and distinctive waveforms despite having identical food ingredients with the same 3 grams of carbs/sugar amount from one large egg. For example, the solid egg meal has higher PPG values than the liquid egg meal with a difference of 23 mg/dL for the peak PPG and 18 mg/dL for the average PPG. In his published neuroscience papers, he described the remarkable physical phenomenon from a neuro-scientific viewpoint.

This comparison study also contains the following two final measurement yardsticks to provide confirmation in using the perturbed method. The first yardstick is to verify the **prediction accuracies** of the two perturbed PPG values via their average PPG of two datasets or waveforms. The second yardstick is to examine the **waveform shape similarity** via their calculated correlation coefficients between the two measured PPG datasets and the two perturbed PPG datasets.

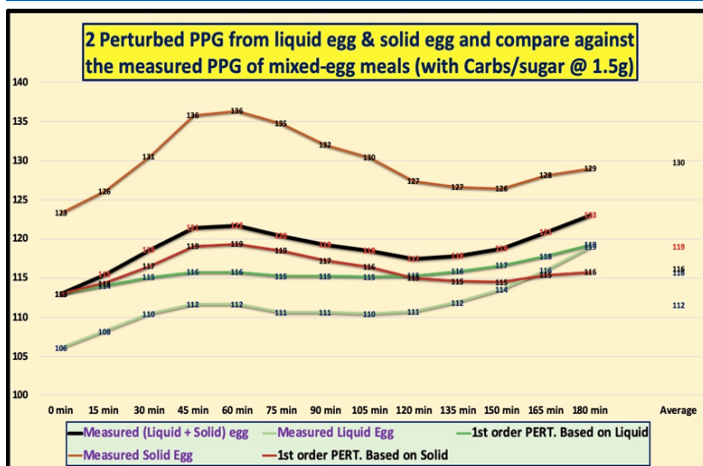
In conclusion, the purpose of this study is to examine the prediction accuracy and waveform shape similarities of PPG from his selected egg meals during a selected time period. He utilizes the first-order of perturbation equations with one selected carbs/sugar amount of 1.5 grams as the identical perturbation factor, which is

between the high-end (3.0 grams) and low-end (0.02 grams) of his baseline meal.

The two conclusions drawn from this research work are listed:

**First, the perturbation equation offers extremely high prediction accuracies with 97% for liquid eggs and 98% for solid eggs.**

**Second, the perturbation equation also provides reasonably high predicted PPG waveform shape similarity with 80% correlation between the measured and perturbed waveforms of liquid eggs and 71% correlation between measured and perturbed waveforms of solid eggs.**



## Introduction

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## Methods

The author has chosen not to repeat all of the details regarding his applied methods as described in other papers. Instead, he outlines a few important equations, formulas, or conditions in this article.

## MPM Background

To learn more about his developed GH-Method: math-physical

medicine (MPM) methodology, readers can read the following three papers selected from the published 400+ medical papers.

The first paper, No. 386 (Reference 1) describes his MPM methodology in a general conceptual format. The second paper, No. 387 (Reference 2) outlines the history of his personalized diabetes research, various application tools, and the differences between biochemical medicine (BCM) approach versus the MPM approach. The third paper, No. 397 (Reference 3) depicts a general flow diagram containing ~10 key MPM research methods and different tools.

## Data Collection

Since 1/1/2012, the author developed a research-oriented software on his iPhone to collect all of his diabetes-related medical data and lifestyle details. In addition, he started to collect his glucose data using a CGM sensor device from 5/5/2018. He accumulated approximately 96 glucose data per day with 13 glucose data per meal over a 3-hour timeframe. On 9/25/2019, he launched a special investigation regarding the relationship between meal preparation methods and PPG levels using his own body to conduct the necessary experiments.

## Neuroscience Study

He described the results from his research work, from 9/25/2019 to 6/30/2021, by utilizing the collected data from his 174 egg drop soup (liquid) meals and 118 pan-fried egg (solid) meals.

The actual research method of this article is identical with his previous three research phases regarding “neural communication model between the brain, stomach, and liver” as shown in his published papers.

## Neuroscience Discussion

With the same food ingredient, why do they have different PPG values?

The two prepared meals have the same nutritional ingredient inputs; however, their different cooking method or meal preparation method lead to different physical states, liquid or solid. Perhaps, in the human’s biomedical system, the initial signal ascending from the stomach to the cerebral cortex is not based on the detailed food ingredients, but rather the food’s arrival message and its associated physical state. Therefore, the brain misinterprets soup as an equivalent intake to a cup of decaf-coffee, tea, or water and then the brain descends a message (or marching order) to the liver to produce or release a lesser amount of glucose.

Another point is, during the period of 5/5/2018 to 6/30/2021, his diabetes conditions were already well under control without medication. This means that these results are strictly from the internal biological outcomes caused by his stringent lifestyle management program, without any chemical intervention by medication.

Based on his big data analytics, the first evidence is that the stomach takes about 10-15 minutes to inform the food entry message to the brain. The second indication is that, for liquid and solid meals, it takes about 45 to 60 minutes for the liver to produce or release glucose to reach to its peak amount. From his previous findings of his diabetes research work, the peak PPG occurring time instants

are usually between 45 minutes to 75 minutes with an average of 60 minutes after eating for most other meals.

When the author could not find a satisfactory explanation from viewpoints of either food nutrition or clinical internal medicine, he started to delve deeper into the source of this problem: the creation of glucose. He realized that glucose is not *directly converted* from food nutritional ingredients. Instead, the glucose was *directly produced or released* by the liver from stored glucoses inside liver or muscle. Of course, the human body and all of its internal organs, in particular the stomach, liver, and pancreas are dependent on food nutrition to convert glucose into their needed energy.

As a result, he came up with his *first hypothesis* that the glucose amount difference is probably due to the physical state of consumed food, such as liquid or solid, that is the used by the brain to make a decision.

Furthermore, the author has learned three basic facts from his past 9-years of biomedical research work. First, 70% of our daily energy intake are consumed by our brain and nervous system. Second, the brain is the only internal organ which has the power of cognition, judgement, information processing, decision making, and marching order issuance, similar to the CPU of a computer. Third, all of the internal organs work closely together but under the orders from a single command center, which is the brain.

Based on the above acquired biomedical knowledge and his acquired computer architecture knowledge (the computer was in fact developed on the understanding of the human brain structure), the author further developed his *second hypothesis*. When one particular food type enters into the gastrointestinal system, the stomach will immediately send a signal to inform the brain about the food arrival message along with its associated physical state. After receiving this input signal from the stomach, the brain will then start to process the information, make proper judgements, and then issue its feedback message (descending marching order) to the liver regarding how much glucose should be produced or released at what time instant and at what time frame to reach to the peak of glucose. At the same time, the brain will also inform the pancreas how much insulin should be produced and released based on the excessive amount of glucose produced or released by the liver. However, for severe diabetes patients whose pancreatic beta cells were damaged to a certain degree, each patient's insulin capabilities and qualities such as the production quantity and insulin resistance will not be the same to make up the final controlled PPG level. The author has also conducted a year-long research project on his pancreatic beta cells' self-recovery rate and published several medical papers regarding this subject. In summary, he has identified his pancreatic beta cells' insulin secretion quality and production have been self-repairing at an annual rate of 2.3% to 3.2% per year, or more precisely, at a 2.7% annual rate from 2015 to 2020. By adopting this 2.7% self-repair rate, he can further modify or "boost" his PPG data and curves by 6.5% (2.7% multiply 2.4 years) to simulate his "should-be" PPG waveform during 2015-2020.

Perturbation Theory of Quantum Mechanics or Modern physics

The author applies the first-order interpolation perturbation method to obtain his "perturbed PPG" waveforms based on one selected carbs/sugar intake amount functioning as the perturbation factors, that is the "Slope". He uses the "measured PPG" waveform as his reference or baseline waveform.

The following polynomial function is used as the perturbation equation:

$$A = f(x) = A_0 + (A_1 * x) + (A_2 * x^{**2}) + (A_3 * x^{**3}) + \dots + (A_n * x^{**n})$$

Where  $A$  is the perturbed glucose,  $A_i$  is the measured glucose, and  $x$  is the "perturbation factor" based on a chosen carbs/sugar intake amount.

For this particular study, he choose his  $A_i$  as  $A_1$ , where  $i=1$ . In this way, the above equation can then be simplified into the first-order perturbation equation as follows:

$$A = f(x) = A_0 + (A_1 * x)$$

Or the first-order interpolation perturbation equation can also be expressed in the following general format:

$$A_i = A_1 + (A_2 - A_1) * (\text{slope } 1)$$

Where:

$A_1$  = original glucose  $A$  at time 1

$A_2$  = advanced glucose  $A$  at time 2

$(A_2 - A_1)$  = (Glucose  $A$  at Time 2 - Glucose  $A$  at Time 1)

The perturbation factor or **Slope** is an arbitrarily selected parameter that controls the size of the perturbation. The author has chosen a function of carbs/sugar intake amount, as his perturbation factor or slope, which is further defined below:

In this particular study, he selects the 0.02 grams as the low-bound carbs/sugar amount and 3.1 grams as the high-bound carbs/sugar amount, while uses 1.5 grams as his selected or perturbed carbs/sugar amount.

Then the "slope" becomes:

**Slope**

$$= (\text{Selected Carbs} - \text{Low-bound Carbs}) / (\text{High-bound Carbs} - \text{Low-bound Carbs})$$

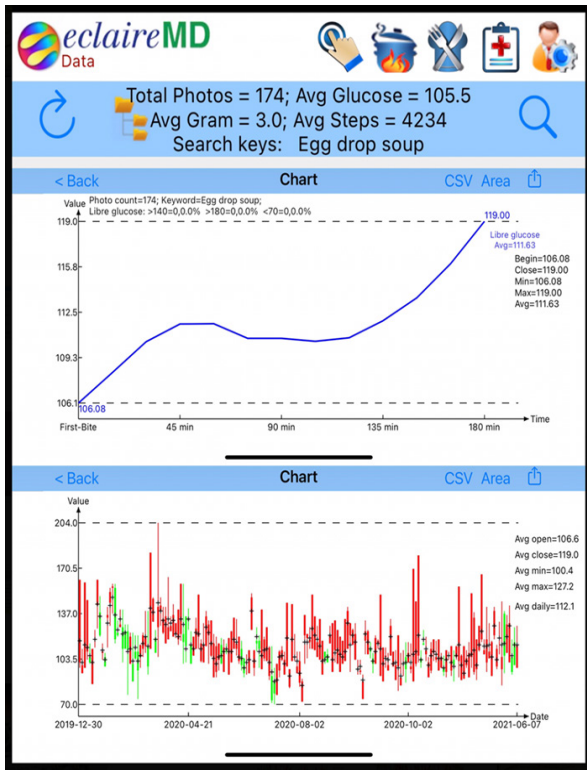
It should be noted that, for achieving a better predicted glucose value, the selected carbs amount should be within the range of the high-bound carbs and the low-bound carbs, where these two boundary carbs amounts should be wide enough in magnitude to include the perturbed value in between.

Therefore, in this particular study, his slope or perturbation factor value has been calculated as:

$$\text{Slope from Carbs} = 0.48$$

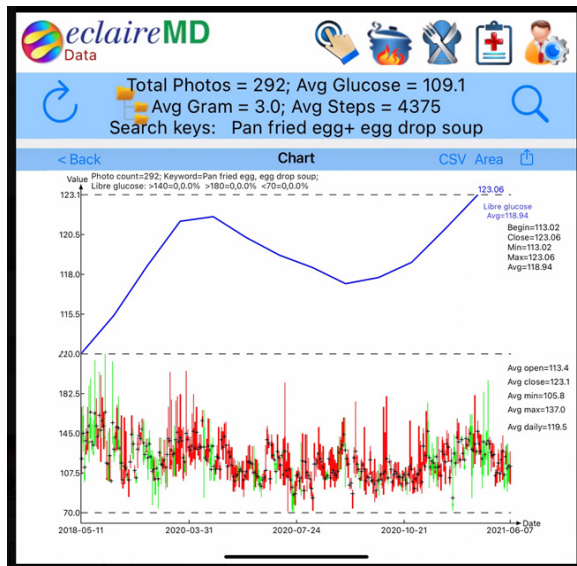
## Results

Figure 1 shows the input data, PPG waveform, and candlestick k-line chart of **174 liquid egg** meals from a 3-year time period from 5/5/2018 to 6/30/2021.



**Figure 1:** Input data, PPG waveform, and candlestick k-line chart of 174 liquid egg meals during the time period of 5/5/2018 to 6/30/2021

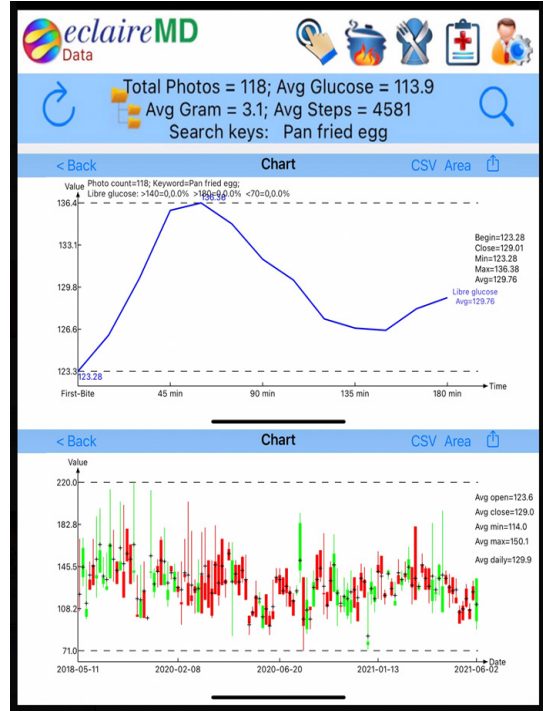
Figure 2 depicts the input data, PPG waveform, and candlestick k-line chart of **118 solid egg** meals from a 3-year time period from 5/5/2018 to 6/30/2021.



**Figure 2:** Input data, PPG waveform, and candlestick k-linechart

of 118 solid egg meals during the time period of 5/5/2018 to 6/30/2021

Figure 3 reflects the input data, PPG waveform, and candlestick k-line chart of **292 mixed meals** with both solid eggs and liquid eggs from a 3-year time period from 5/5/2018 to 6/30/2021.



**Figure 3:** Input data, PPG waveform, and candlestick k-line chart of 292 mixed meals of both liquid eggs and solid eggs during the time period of 5/5/2018 to 6/30/2021

In comparison of these three figures, we can observe that the PPG value differences in the format of (average PPG, peak PPG, synthesized GF, and K-line GF). Here, the GF is defined as the glucose fluctuation amount of the maximum PPG value minus the minimum PPG value.

- 174 liquid: (112, 119, 13, 27)
- 118 solid: (130, 136, 13, 36)
- 292 mixed: (119, 123, 10, 31)

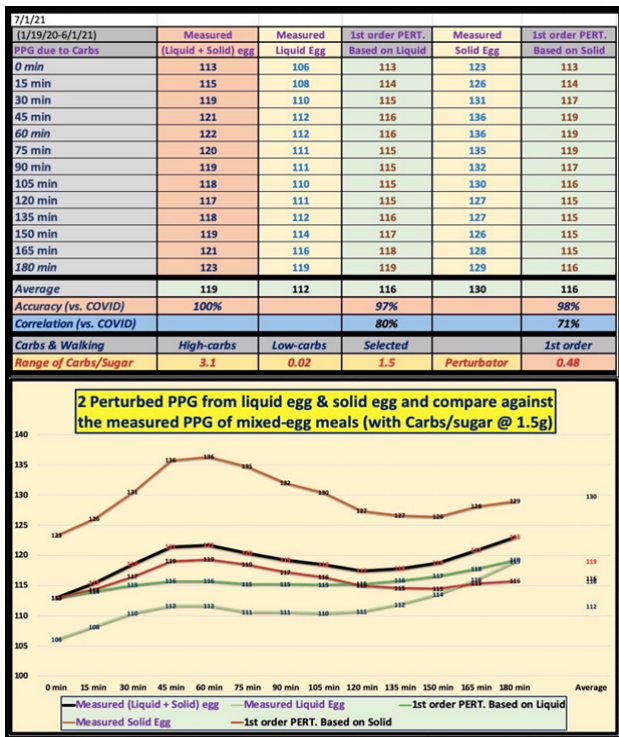
The PPG differences between solid (higher) and liquid (lower) are:

**Average PPG difference**  
= 18 mg/dL  
**Peak PPG difference**  
= 17 mg/dL

The glucose fluctuation values are comparable to each other between liquid eggs and solid eggs.

Figure 4 illustrates the calculated data table and results comparison between two resulting perturbed PPG waveforms against three

measured PPG waveforms: liquid, solid, and mixed. Based on a neuro-scientific viewpoint, the brown solid curve for solid eggs is the highest, the grey liquid curve for liquid eggs is the lowest, and the black mixed meal is in the middle.



**Figure 4:** Calculated perturbation factor, and perturbed PPG waveforms in comparison with 3 measured PPG waveforms during the time period of 5/5/2018 to 6/30/2021

Applying the perturbation theory, both the average perturbed solid PPG value of 119 and the average perturbed liquid PPG value of 116 are quite close to the average measured mixed meals PPG of 116, since the measured mixed egg meals was chosen as the baseline or referenced waveform. **These observations can be confirmed numerically by the exceedingly high prediction accuracy of 97% for liquid eggs and 98% for solid eggs.** As a result, the extreme high prediction accuracies of applying perturbation theory from quantum mechanics on certain medical issues and a few biomedical phenomena have been demonstrated.

With an eye observation of the perturbed curve versus the measured curve, **the red solid perturbed curve and the brown solid measured curve have a high correlation coefficient of 71%, while the green liquid perturbed curve and the grey liquid measured curve have an even higher correlation coefficient of 80%.** Therefore, the high waveform shape similarities between the two perturbed curves and two related measured curves have been proven.

### Conclusions

In conclusion, the purpose of this study is to examine the prediction accuracy and waveform shape similarities of PPG from his selected egg meals during a selected time period. He utilizes the first-order of perturbation equations with one selected carbs/sugar

amount of 1.5 grams as the identical perturbation factor, which is between the high-end (3.0 grams) and low-end (0.02 grams) of his baseline meal.

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