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Exploration and Assertion of the ‘Theory of Potential’ using Human Brain Signals

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Abstract:- It may happen that exceptional self-organisation of oneself can lead to the breaking down of old patterns and hence the birth of a new pattern. This new pattern causes a new mindset for that individual, and thus this individual perceives the world differently while being in a higher state of mind. So far, it was posited theoretically and qualitatively by Dr. Flower that this type of manifestation occurs because previously untapped cognitive neural cells are now allowed to create a new neuronal pathway leading to a new path of cognition and human development. Dr. Langham found a model based on his observation on the creation of a cell and this model follows three distinct phases of this cell development. He developed this model in order to produce an overall concept to decode and clarify information in various disciplines. This developed model consists of three phases that are the (i) creative phase, (ii) organizational phase and (iii) functional phase and each phase consists of different number of aspects which in turn exhibit certain characteristics. This research used mathematical methods as well as signal analysis to better understand the underlying behaviour of those characteristics. Analyses demonstrated the presence of duality in the signal data (high peaks and low peaks, or maxima or minima respectively), there are specific movements that occur in the brain signal data and these movements are functions of π. The 3D dimensional analysis of the brain signal data shows how the information in the brain describes the development of a thought process through time which mimics the aspects of the developed model. These aspects help in understanding better the cognitive development and the human decision-making process that occurs in the human brain. Moreover, these exciting results that are obtained here can be extrapolated to other research areas, and will open doors for these disciplines to explore how to use and interpret those aspects in their respective fields.

Keywords: *Theory of Potential, Human Understanding, Langham’s Concept, Brain Signal, Cell Development*

I. INTRODUCTION

The dynamic system application to cognition development is considered to be best presented by physical theories from Natural Science (Flower, 2006; Flower 2015) as opposed to theories that emanate from syntax and artificial intelligence. It is argued that psychology is the description of the cognition and behaviors of an agent under certain environmental pressures. Very often there is the occurrence of transition phases in cognition development where old patterns broke down. For example, when an athlete makes an instinctive move or action, or when a combatant makes a heroic move, these types of actions occurred owing to exceptional self-organisation causing a new elevated mind state. This process is alike to an action named the "Scalloping" which is the repetitive building up as well as collapsing of complex performance but this self-organizing action does not necessarily manifest through repetition. Instead, it is a qualitative theoretical proposition that the said manifestation which is an opening of the previously untapped "cognitive cell's" which permit the creation of a new path of cognition and human development (Langham, 1974; Flower, 2015; Flower, 2019).

One of the most dynamic GST models that has been researched here is a Natural Systems concept (Flower, 2006; Flower, 2015; Flower, 2015). Langham(1969), who specialised in plant genetics, discovered a model which was based on the creation of a cell and this model consists of three distinct parts. The concept of the model is based on the structure, the principles as well as the relationships that he observed as operating in the cell's development. Langham (1969) and Flower (2006) developed the aforesaid concept to serve as a means to synthesize, synchronize and organize data. The concept is able to decode and clarify information. The three main parts of the model are identified as (1) creative phase, (2) organisational phase, and (3) functional phase. These three phases break down into segments as follows: three creative segments, six organisational segments and four functional segments which give a total of thirteen segments. After a thorough pursuit of the Langham theorem, it is suggested that it is feasible that the principles of cell development can be applied to human understanding. Langham's thirteen principles can provide a paradigm which is able to integrate various disciplines pertaining human understanding by virtue of a common biological focus ground. The Langham's model can decode as well as clarify information. Moreover, information can be expressed as dichotomous responses such as yes or no, on or off, up or down similar like in a yin-yang manner. This is the universality of the Langham model which represents a system of the whole and parts as well as polarity. In addition to that there are currently no satisfactory processes that explain changes that occur physically, mentally, emotionally and spiritually but there is possible theory that can address all of these and it is called the theory of potential science. This theory of potential science has its basis in biology and it is related to the aspect of cellular development which was discovered by the genetist Dr. Langham and the cosmological aspect of the science of potential was created by the Gilchrist institute through the implementation of concepts of Leibnitz, Descartes, Spinoza, Einstein and Aristotle (Flower, 2006; Flower, 2015; Flower, 2019).

A. Science of potential theory

Aristotle conceived the notion of potential while Einstein established the concept of the fundamental unit of the universe as a "pantheistic" notion. Descartes came a little closer to the concept of a potential molecule which was devised by Dr. Robert J. Flower and Dr. Langham by means of the "corpuscles" notion. Furthermore, Leibnitz come closest to the concept model by his Monads which represented the essence unit. Each monad was unique and each was subjected to creation and annihilation. Each monad knew what to perform based on its creative and annihilation directive.

B. Development of the concept of Potential Molecule

By virtue of the development of the cell, it is found that the process of the creation has three components or phases: (1) creative phase, (2) organisational phase and (3) a functional phase. These three aspects break down into 13 aspects. This potential molecule contains these 13 aspects and these can build-up to solid natural/physical reality which is in a sense 'pantheistic'.

➢ *Creative phase*

Langham discovered the living geometry of a cell (Langham, 1969). His geometrical model was based on title-specific principles identified during the creation of a cell. The model contains three parts which are pulse, wave and spiral. Cell development starts with 180 degrees polar pulses within the seed, and this initial pulse starts from North to South followed by an East to West pulse at 90 degrees to the original pulse which form the X-Y axes of the cartesian coordinate system. The final pulse of the creative phase is a front-to-back movement forming a 3-dimensional Z-axis. This completes the cell's creative phase of development.

➢ *Organisational phase*

For the organisational phase of the cell development, the cell then explodes into a wave-like motion attaining a maximum radius or expansion point in each direction of the three axes. The organisational phase consists of waves owing to the expansion (explosion) of the cells emanating from the 3 axes (*X*, *Y*, and *Z*) and therefore it consists of 6 aspects based on the directions of these 3 axes (3 x 2). The six wave motions actually complete the organisational phase of the cell development.

➢ *Functional phase*

Last but not the least, the third and final stage of the cell development is the Functional phase in which the cell begins to spiral, specifically at its corners. The spiraling impacts four points within the cell which best illustrated as a neutron spiraling around the earth, touching both poles and the two opposite points along the Equator line. These represent points that are found on the corners of the cell (North (N), South (S), East (E), and West(W)).

The result gives 13 aspects of the cell geometry: three in the creative phase, six in the organisational phase and the four in the functional phase and these 13 aspects are important in cell development. One important principle of the model is that each phase shows clearly the property of polarity in the 180^0 movements of the pulse, wave as well as the spiral patterns. The research methodology that was employed in this study is elaborated in the following section.

II. RESEARCH METHODOLOGY

In this research, brain signals from a healthy human subject performing rapid serial visual presentatation (RSVP) tasks were employed to explore the theory of potential science. The reason for the use of this type of brain signals is that the human participant, every time, has to make quick decision based on cognitive tasks that they have never performed before and by making quick decision, specific neural pathway should be in place or created so as the human participant can perform well in that particular cognitive tasks or there is a change in neural pathway depending on the rapidly changing visual task and the associated actions that are required to respond to such task (Chuckravanen, 2014; Chuckravanen et al, 2015). Therefore, the Langham's concept were applied on one individual healthy human subject's electroencephalogram (EEG) data (Matran-Fernandez and Polo, 2017). This EEG data was recorded from the healthy participant upon the presentation of images through the rapid serial visual presentation (RSVP) protocol at speeds of 5 Hz. The images contained targets (airplane superimposed on an image) or non-targets (that is there is no airplane in an image). The participant had to press appropriate button on a keyboard to notify whether an image contains a target or non-target, and therefore an unbiased decision. EEG samples were measured in microvolts (μV). The annotation T represents the presence or absence of the target image respectively (when T = 1, this means the presence of a target image, or when T=0, this means the presence of a non-target image).

In the converted EEG data, there are 8 channels, our focus was mainly on the visual part **(occipital part)** of the brain which is denoted by the *left hand side* and the *right hand side* of the visual system that are O1 and O2 as well as **parietal part** of the brain denoted by P7 and P8 and these lobes play important roles in the visual decision making process (especially in the visual pathway to the processing of information and respond to that information) (Chuckravanen, 2014; Chuckravanen et al., 2015; Rehman and Khalili, 2019).

EEG data are in the frequency range of 0.15 Hz to 28 Hz and the sampling rate is 2048Hz. According to Nyquist's theorem, one can sample a dataset at least **2*Fmax** where **Fmax** represents the maximum frequency component that were found in the EEG signal and therefore the EEG data was resampled to 100Hz to be able to analyse the EEG data using less heavy computational power and also observe the data holistically which is important to observe the general trend in the EEG signals for a specific duration of time.

➢ *Pre-processing of the brain signals*

The collected EEG data format was originally in EDF format and then programming codes developed in Matlab software R2009a were used to convert EDF format to matlab format (*.mat) in order to analyse the EEG datasets. The original EEG record was of a matrix of data 10 x 829440 and it was downsampled by a factor of 8 to produce the following figures which consists of the four brain signals (parietal P7, parietal P8, occipital O1 and occipital O2).

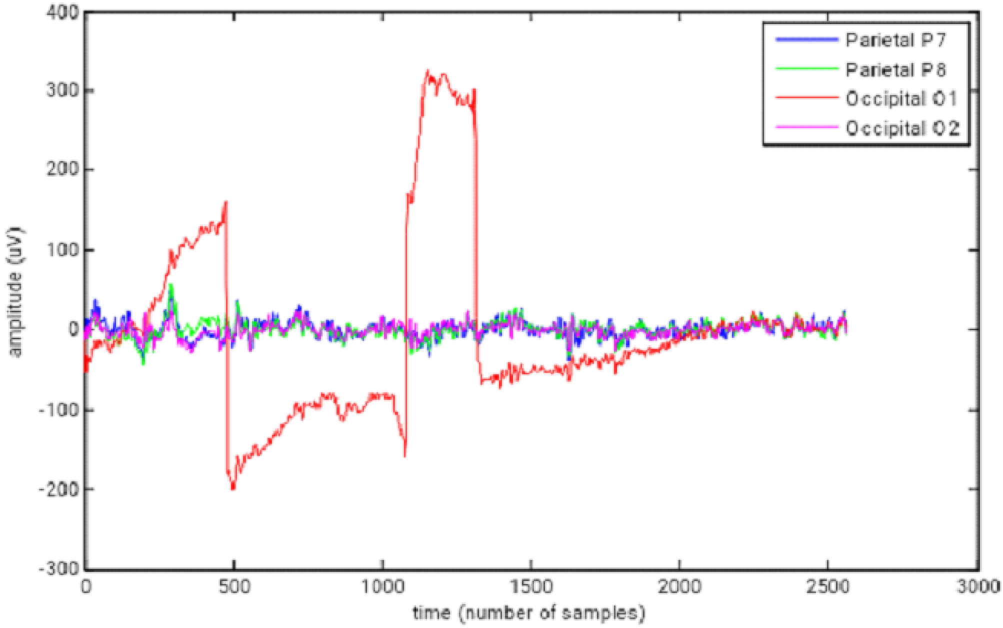


Fig 1:- Four EEG data were plotted against time (measured in terms of number of samples)

According to the visual observations of the EEG data in Figure 1, the amplitude for occipital O1 is too large and therefore O1 is opted out and analysis will be focused on the remaining 3 types of EEG data.

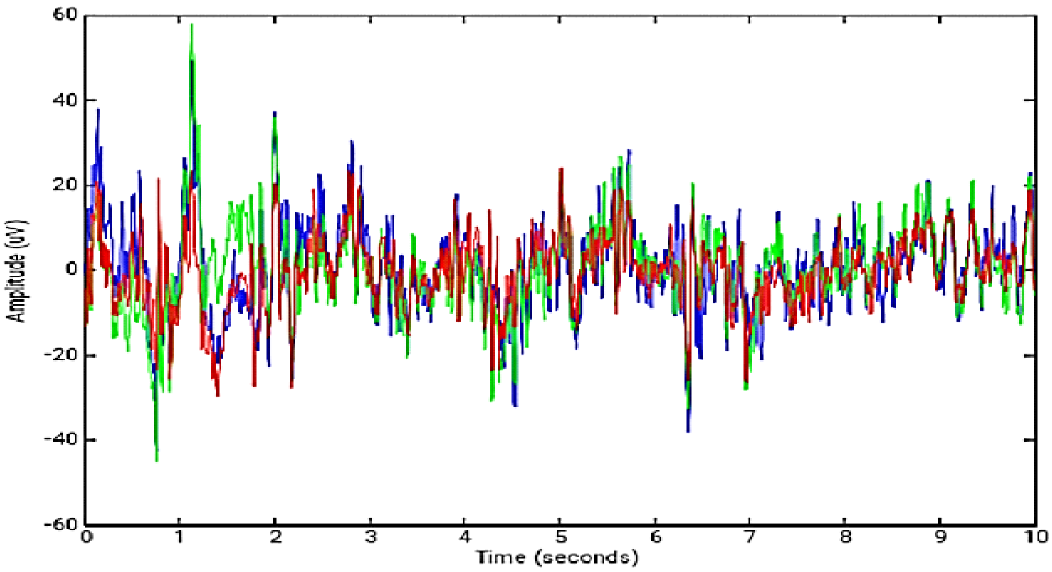


Fig 2:- Three types of EEG data (Parietal P7 (blue), Parietal P8 (green), and Occipital O2 (red)) are shown here.

Furthermore, as the peaks are well illustrated in the parietal lobe (P8) (the green curve), the parietal P8 EEG data is isolated from the other two EEG signals (See Figurer 2) and it is then illustrated in Figure 3 for further analysis purposes.

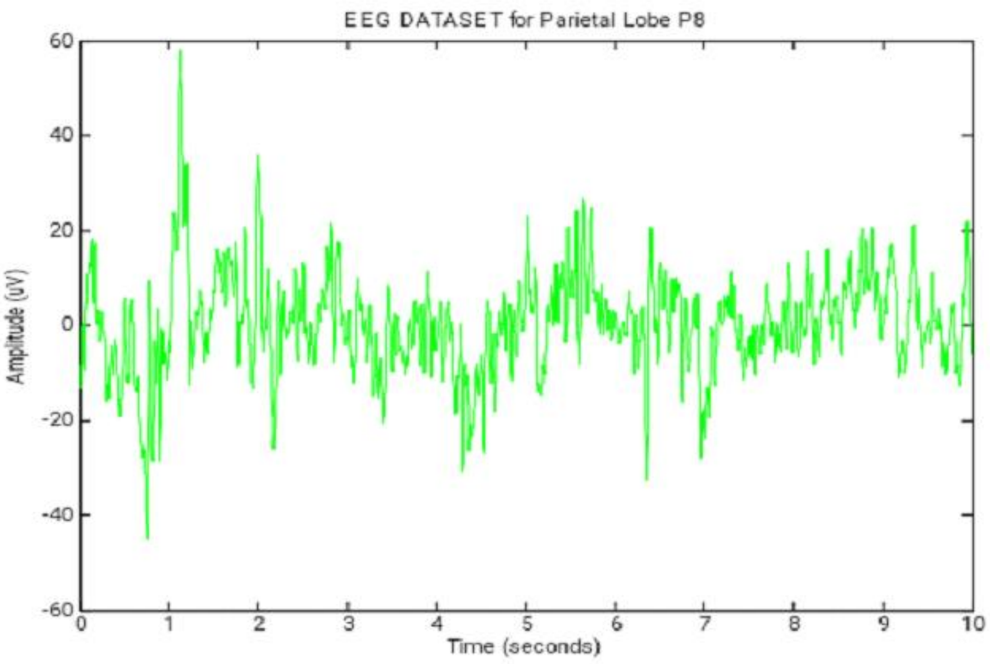


Fig 3:- The selected dataset for analysis (Parietal P8) of the human brain

III. RESULTS

The data to be used for subsequent analysis is the Parietal P8 Brain signal and it is shown in Figure 3. From this figure, the three types of pulses that occur during the creative phase are explained.

A. Creative Phase – First Pulse: Initial Pulse

From the Figure 3, it is observed that there are general trends of movement from a maximum peak to a minimum peak. The peaks decrease from a **maximum value to a minimum value**. These peaks are significant peaks at the start of the decision-making process. Next, the value of the phase differences between the maximum peaks and the minimum peaks were investigated and they are summarised in Table 1.

Peaks	X-ordinate	Y-ordinate	Difference in X-ordinate (local) (seconds)
Peak 1	1.129	57.55	Peak 1 to Peak 2 0.1050
Peak 2	1.234	-9.643	
Peak 3	2.004	35.95	Peak 4- Peak 3 0.1760
Peak 4	2.18	-26.42	
Peak 5	2.816	21.48	Peak 6 – Peak 5 0.0430
Peak 6	2.859	-6.705	

Table 1:- The coordinates of the minimum and the maximum peaks (**local ones**) based on Figure 3 for the first 3 seconds.

Even that the difference in times of the consecutive maximum and minimum peaks are different, it is well known that in the brain there is the presence of a range of frequencies and the difference between the maximum and minimum consecutive for any default wave is given by the following sinusoidal equation which is expressed as:

Y = A* sin (wt), …Equation (1)

where **A** is amplitude and **w** is the angular frequency and it is measured in radians per second

Y = sin (2πft), …Equation (2)

where **t** is time and **f** is frequency is measured in Hz.

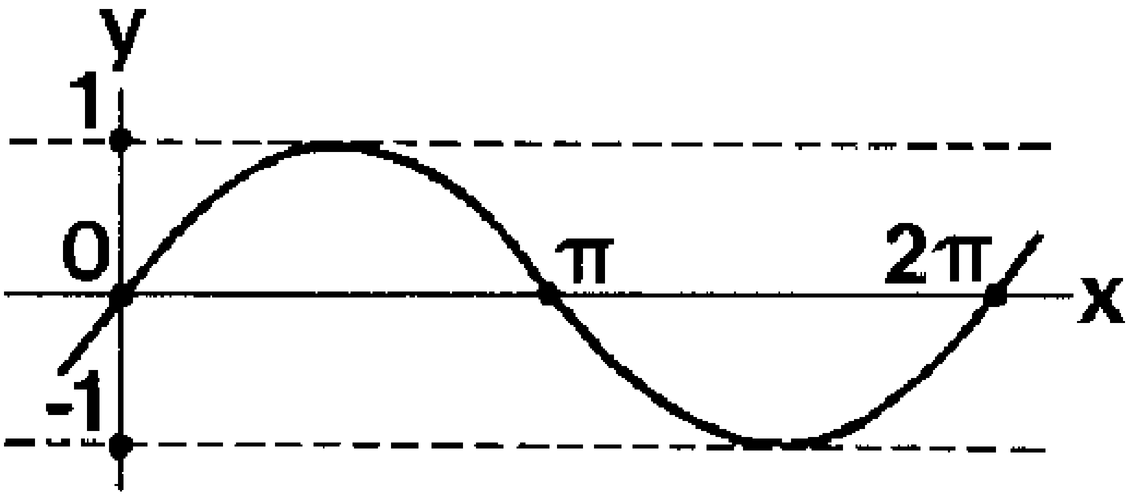


Fig 4:- Sine curve with Amplitude **1** and Period **2π**

Therefore, by investigating a simple sine wave as shown in Figure 4, it can be stated that the difference between two consecutive peaks (maximum and minimum is just ***π***) as shown in Figure 4 with amplitude 1. Thus, the initial pulse for the creation of thought to initiate an action (for instance) follows the same principle for the creation of cell (***pulse of action***). The movement occurs from the maximum peak to the minimum peak (as depicted in Figure 3) and the phase difference is ***π***. This is in line with what was suggested by Dr. Flower in his paper (Flower, 2006; Flower, 2019) where he applied the Langham's concept on financial data. Therefore, the initial pulse for the creation of thought P= F(***π***) where F is a function. Next analysis demonstrates the second pulse for the creative phase of the cell development.

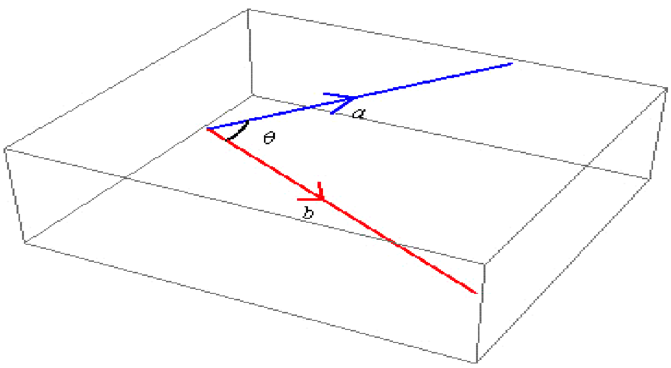
B. Creative Phase - Second Pulse: Pulse of action

In order to show the East to West movement at **π/2** to the initial pulse of action, we need to investigate the **scalar product** of the direction of the tangent at the minimum of a peak, and the slope north to south should be able to approximately equal to the **π/2 - phenomenon**.

➢ *Proof from the principles of Scalar Product theory*

It is well known that the gradient of the tangent of a minimum or a maximum is always 0 and therefore in our case we are interested in the gradient of a minimum point (as shown in figures 3 and figure 4) which is 0. If a peak occurs, automatically this insinuates that the tangent at that point should be 0. In order to illustrate this, consider the following mathematical scenario:

Let the Gradient of tangent at any minimum point = ***m*** , and let the gradient of slope connecting any minimum point to a maximum point be = ***k***. Therefore, by taking the scalar product, it is known that if the vectors *a* and *b* have magnitudes *a* and *b* respectively, and if the angle between them is θ, then the scalar product of *a* and *b* is defined as:



$\mathbf{a.b}=ab\cos\theta$ … Equation (3)

$\mathbf{m.k} = \mathbf{mk}\cos\theta$ ... Equation (4)

However, it is well known that the gradient of a minimum is always **0** as there is no rate of change in respect to x-axis.

Therefore, the gradient *m* is 0 and equation (4) reduces to:

$\mathbf{0.k} = \mathbf{mk}\cos\theta$ ... *step 1*

$\mathbf{0} = \mathbf{mk}\cos\theta$ ... *step 2*

$\cos\theta = 0$ ...*step 3*

and thus

- $= \cos^{-1}(0)$

...*step 4*

Possible values of θ = {π/2, 3π/2, 5π/2 … multiple of π/2}

Therefore, it is shown that the direction of movement for the second pulse happens at a multiple of π/2 radians of the original direction of movement (initial pulse) with the minimum value being π/2.

C. Creative Phase – Third Pulse: Front to Back Pulse

From figure 3, it is clearly observed that there is a shift in sign value of EEG data from positive to negative. In order to observe this, we will do plots (direction field of the EEG data) based on first order differentiation of the EEG data.

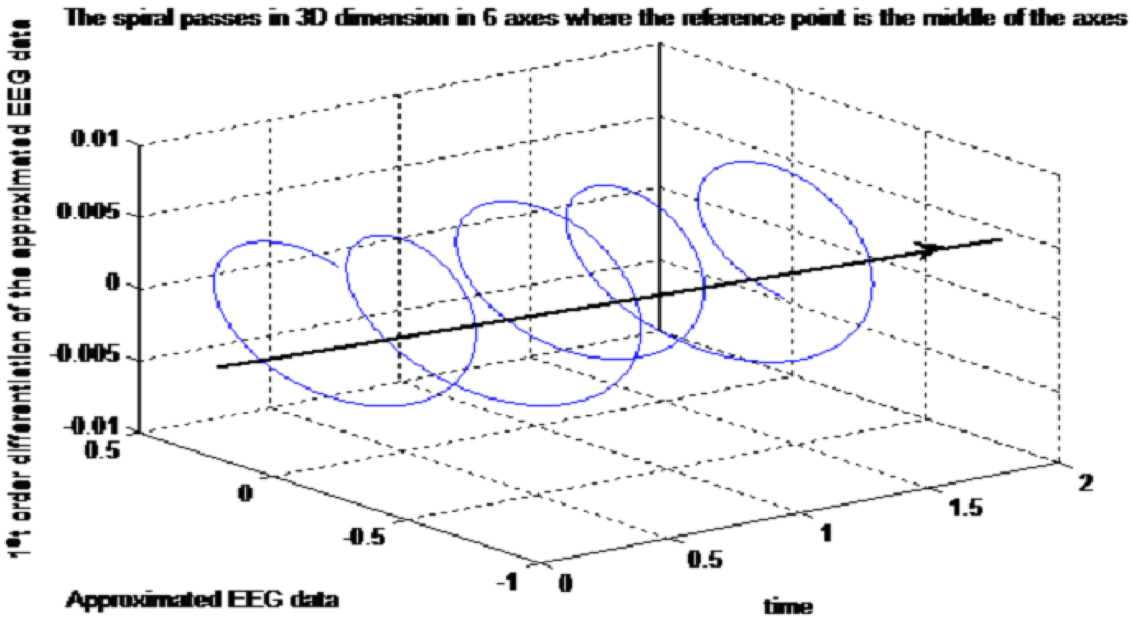


Fig 5:- Three-dimensional view of the parameters time (x-axis), and EEG voltage through time (Y-axis) and the direction field of the EEG through time (Z-axis).

Based on Figure 5, it is clearly observed that it appears a flow of movement from the front (start of the creative phase development) to the back. One should not get confused that the 'back' means backward in time but rather the contrary as it follows the sequence of definite pulses (initial pulse, second pulse and the final pulse) for the creative phase of development.

D. Organisational phase (waves) – 6 waves in the 3 directions x, y and z-axes

During the organisational phase, the cell explodes into a wavelike motion. Let us investigate how wavelike motions can be felt in each axis. In order to achieve this, Fourier series mathematical algorithm was used to depict the general trend of the complex EEG signals. However, before going into the fourier series analysis, one should know that fourier series analysis is a way to break a signal or a periodic signal into cosine functions as well as sine functions, and these cos and sin functions will create the wavelike motion and thus the creation of spirals in the functional phase.

Fourier series of any 'periodic' signal, g(t), can be expressed as:

$$g(t) = a_0 + \sum_{m=1}^{\infty} a_m \cos\left(\frac{2\pi mt}{T}\right) + \sum_{n=1}^{\infty} b_n \sin\left(\frac{2\pi nt}{T}\right)$$

$$= \sum_{m=0}^{\infty} a_m \cos\left(\frac{2\pi mt}{T}\right) + \sum_{n=1}^{\infty} b_n \sin\left(\frac{2\pi nt}{T}\right)$$

… Equation (5)

Where a_0 is a constant, a_m and b_n are coefficients of the cos function and sin function respectively. The EEG signal is approximated by the fourier series representation. In order to do this, the normalised EEG data (at parietal P8) is obtained by dividing the EEG data by the modulus (irrespective of whether the value is negative or positive) of the maximum value of the EEG data.

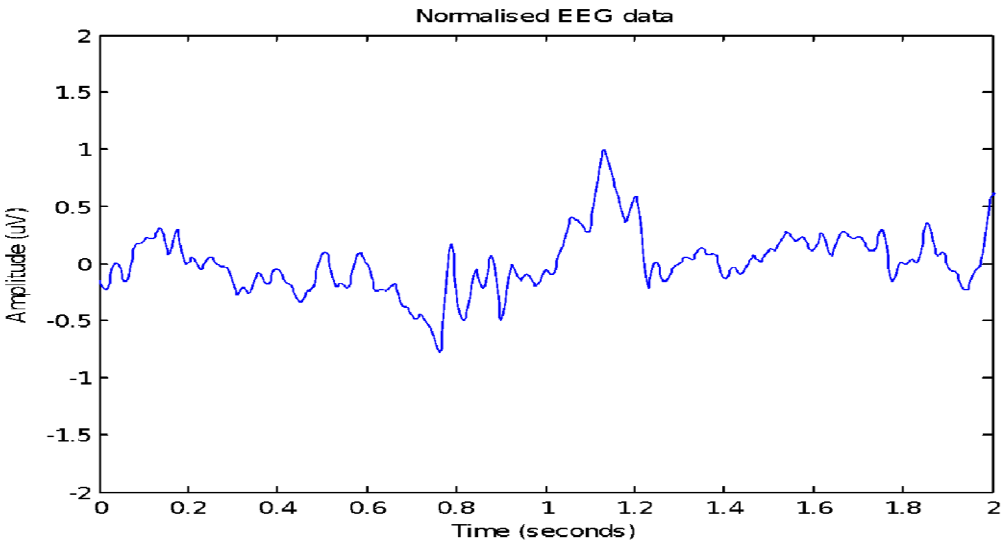


Fig 6:**-** Normalised EEG data (Parietal P8)

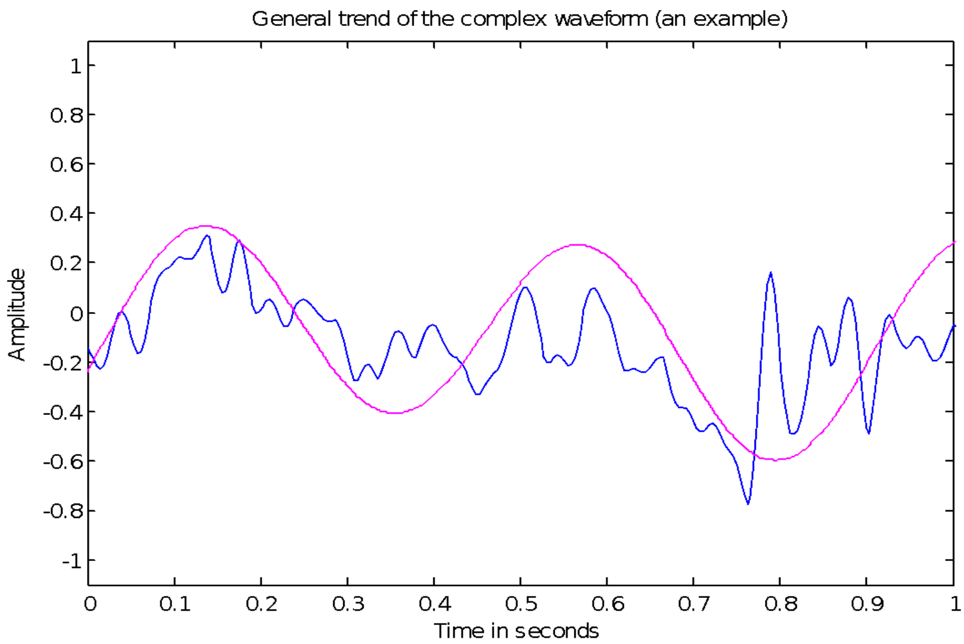


Fig 7:**-** The general trend of the EEG curve using the first order terms of the fourier series and the constant a_0.

A holistic trend of the EEG data can be generalised by the pink curve but it is not totally a sin curve or a cosine curve but rather a mixture of cos and sin functions. For this research, only first order terms and the constant of the fourier series were employed for simplication, the general trend of the curve is illustrated and the equations underlying this general trend are as follows:

$$F(\mathbf{t}) = 0.1*\mathbf{sin}(0.7*\pi*f*(\mathbf{t}-0.13) + 0.5) + 0.4*\mathbf{cos}(1.5*\pi*f*(\mathbf{t}-0.13)) - 0.1 \quad \textbf{...Equation (6)}$$

Equation (6) is one potential representative equation and this can be improved by adding more terms to create a more accurate graphical representation of the EEG signal but in this study, we are more concerned in the general trend of the data as EEG physiological data is a very complex function.

➢ *Why one needs to think in Fourier?*

By thinking in fourier (or in another dimension), one can perceive complex signals as a summation of cos-curves with different frequencies and sin-curves with different frequencies with a constant.

Therefore, by having these two types of functions with time, we can make graphical displays of these combined function in 3D dimensions.

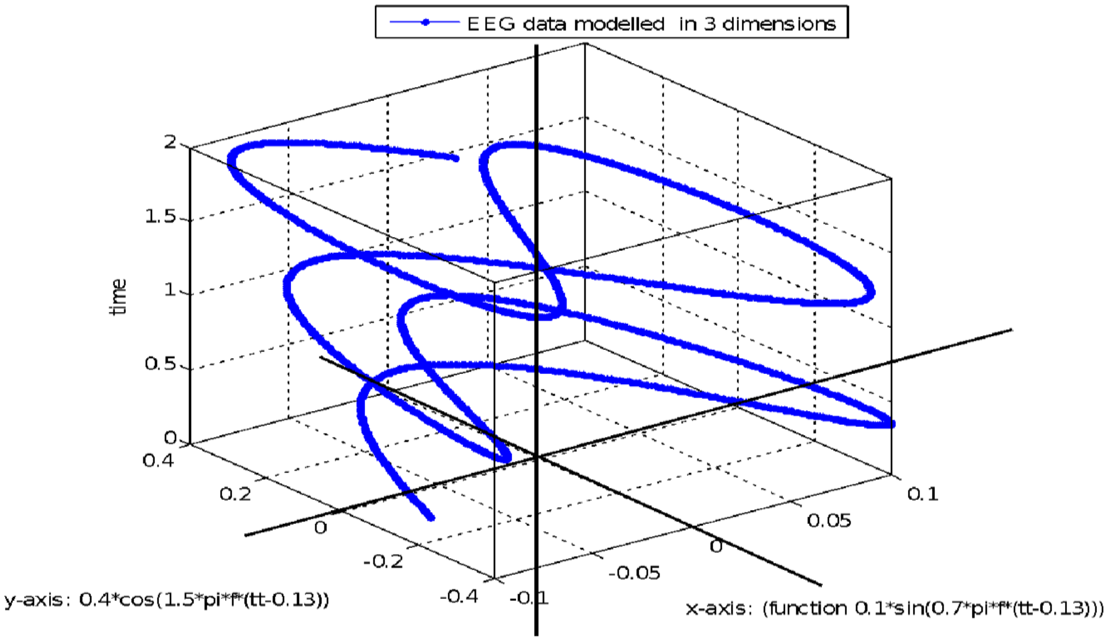


Fig 8:- 3D illustration of EEG data trend using 1st order Fourier series to demonstrate the movements of the signal in 6 directions using Equation (6).

Now, from this 3D dimension, one can clearly observe the 3D movements of the path of the thought processes that happen in the brain for a time duration of 2 seconds while making decision. Now, in neuroscience, it is well known that before a person effectuates an action, about 600ms before the action, the thought is born and then after 600ms, the action is effectuated based on the decision made on a particular action. Therefore, the 3D dimension of the pathway consists of 6 directions and these can be easily observed using the **(0,0,0)** coordinates as the reference point. The direction ***x*** extends on both sides of the ***x* <–> *x'*** direction, the direction ***y*** extends on both sides of the ***y*<–>*y'*** direction as well as ***z*** direction extends on both sides of the ***z* <–> *z'*** direction. Please note that for the *z*-direction, there is already the birth of a thought process or decision-making before the execution of an action and this occurs for a duration of 600ms before the initiation of actions by a normal healthy human being. Therefore, the property of Polarity (Flower, 2006; Flower, 2015; Flower, 2019) is preserved also in the organisational phase as there are 180 degrees movement in all 3 axes.

E. Functional Phase (Spirals) – 4 corners (North, South, East and West)

For the spiral aspect, the following diagrams are formulated based on the functions in representing the EEG data using the first order of the Fourier series. The functions represent a summation of ***cos*** functions and ***sin*** functions as well as a constant.

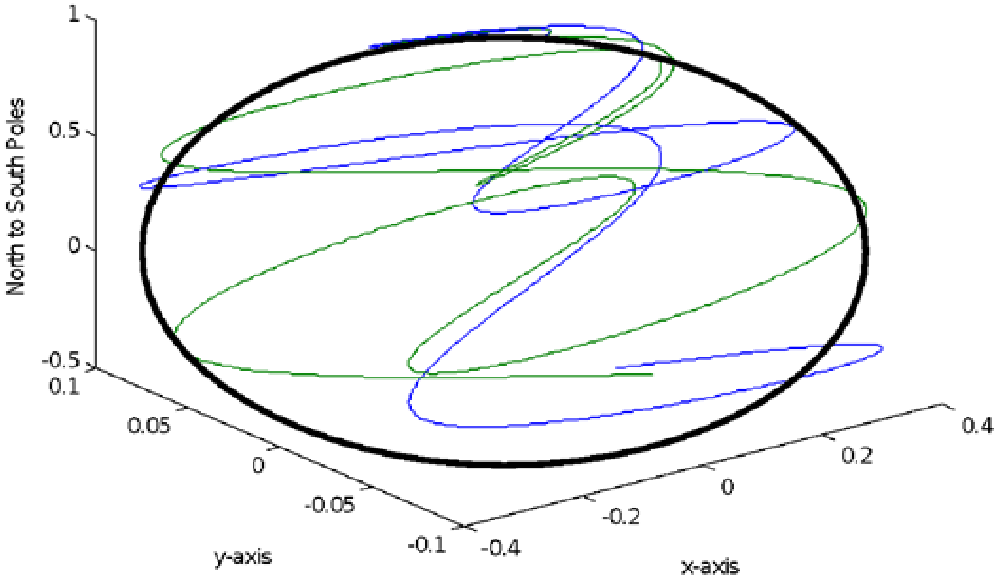


Fig 9: Manifestations of the movements that occur during the functional phase of 'cell development' or the potential molecule.

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From Figure 9, the manifestation of movements are clearly observed between the North pole and the South Pole of the dotted elliptical shape. There is also a movement in the x-y axis and this may be related to the 'equatorial' movement as mentioned by Dr Flower (Flower, 2006; Flower, 2015). These 4 aspects represent the functional phase of the cell development. In the above figure, the cell or the thought process spirals through these 4 aspects. Here also the 180 degrees movement is preserved which is an important property of polarity.

IV. DISCUSSIONS

Langham (1969), a geneticist working with plant cells, found out the living geometry of a cell and the geometrical model was developed according to specific observed characteristics that were found during the creation of a cell. This model consists of three main components that are pulse, wave and spiral. This research employed a different approach of understanding the cell development geometry or the potential molecule as posited by Dr. Flower (Flower, 2006; Flower, 2015; Flower, 2015). The creation of thought is 'intangible' similar like the potential molecule but the creation of thought follows a process. For instance, a human being performing rapid visual processing cognitive tasks has few seconds to understand and respond to a cognitive task and therefore, there is the creation of thought that passes through neural pathways (frontal to parietal to occipital brain lobes) and when the next cognitive task is presented to the person, he has to switch his thought or maintain his thought process in order to perform well and fast a particular cognitive task which is presented visually to him or her.

Results from the first phase of this research study, that is the creative phase, demonstrate that there is in fact an initial pulse that occurs in the EEG signals as the significant peaks that were found in the EEG signal decrease subsequently from maximum values to minimum values. The phase differences between the maximum peaks and the subsequent minimum peaks are functions of π. This finding is in line with Dr. Robert Flower who applied similar concept on Financial time series data (Flower, 2006). Therefore, the initial pulse for the creation of thought process is a function that depends on $\boldsymbol{\pi}$. This study also demonstrated that the second pulse of action manifests in by means of $\boldsymbol{\pi/2}$ **-** phenomenon and this was proven using scalar product theory. The third pulse of the creative phase of the cell development or the potential molecule was successfully shown using a 3D-representation using spiral structures. The 3D-representation of the EEG data using the EEG data itself, its first order differentiation through time as well as time factor show how the thought process spirals through time. The famous mathematician/philosopher Pythagoras used the creative phase principles in terms of 3 points that are awareness, beliefs and communication.

Next, research findings from this work show that when the EEG data is represented or modelled in terms of general trend using 1st order Fourier series, the EEG data can be represented in 3D dimensions using a summation of cos and sin functions. One can observe how the EEG data evolves through time. The EEG data evolves in all 6 directions of the 3 axes. Therefore, we have shown the presence of the six aspects of the organisational phase of the cell development or the potential molecule or the process of thoughts in human cognition. Another example of the presence of the 6 aspects are found in the laws of the rules of the natural sciences that are models, details, processes, measurement, mirroring and wholeness as well as in the principles of mathematics that are laws, parts, order, assessment, reflection and synthesis.

The last phase but not the least is the functional phase. In the functional phase, we have also observed that the spirals cornered the four points that are the North, South and the x-y axis or two opposite sides of the 'equatorial' plane. In one way, it is shown that the functional phase does have these 4 points characteristics and the Psychologist Carl Jung implemented those principles as a basis for his behavioral model and they also form the basis for the Meyer-Briggs personality test. They are physical, mental, emotional and intuitive.

All in all, this basic matrix is an application model which provides the means to take a problem, define it, and then explain as well as investigate it from the standpoint of each of the interrelated principles. Here, this research has analysed the theory underlying potential science from an EEG analysis perspective and demonstrates mathematically or through signal processing that the EEG data consists of the 13 aspects as posited by potential science theory for human understanding.

V. CONCLUSION

This research used brain signals from a healthy human being to support the 13 aspects that are constitute the cell's development by using methods such as mathematical analysis and signal analysis. As common to nature, things change and it can go up or down and this is the basis of sinusoidal function. We have demonstrated in this research that there is a strong presence of duality in all the phases of the cell's development or the creation of the 'potential molecule' or in the development of a thought process. The manifestations or movements that occur in human decision making are in function of π, and it was also shown that there are the strong presence of cos as well as sine functions and these two combined together can produce complex functions to mimic the nonlinear behaviour of complex 'living things' or thought processes or in our case it is human decision-making process.

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APPENDIX (CODES)

```
%analysing EEG signals
% specifications of one channel of the signal (to observe attention)
% hdr =
%
%          ver: 0
%    patientID: [1x80 char]
%     recordID: [1x80 char]
%    startdate: '06.02.13'
%    starttime: '22.49.26'
%        bytes: 2816
%      records: 405
%     duration: 1
%           ns: 10
%        label: {1x10 cell}
%   transducer: {1x10 cell}
%        units: {1x10 cell}
%  physicalMin: [1x10 double]
%  physicalMax: [1x10 double]
%   digitalMin: [1x10 double]
%   digitalMax: [1x10 double]
%    prefilter: {1x10 cell}
%      samples: [2048 2048 2048 2048 2048 2048 2048 2048 2048 57]
%    frequency: [2048 2048 2048 2048 2048 2048 2048 2048 2048 57]

[hdr,record]=edfread('rsvp_5Hz_02a.edf');

T=10; %duration of the task - i am selecting a portion of 10 seconds for the analysis purposes

Fs=2048; % sampling frequency was set to 2048Hz

EEG1=record(1,1:Fs*T); %the duration of EEG recording can be changed here
EEG2=record(2,1:Fs*T);
EEG3=record(3,1:Fs*T);
EEG4=record(4,1:Fs*T);
EEG5=record(5,1:Fs*T);
```

```
EEG6=record(6,1:Fs*T);
EEG7=record(7,1:Fs*T);
EEG8=record(8,1:Fs*T);

%downsample (2048/256=8)
EEG11=downsample(EEG1, 8);
EEG21=downsample(EEG2, 8);
EEG31=downsample(EEG3, 8);
EEG41=downsample(EEG4, 8);
EEG51=downsample(EEG5, 8);
EEG61=downsample(EEG6, 8);
EEG71=downsample(EEG7, 8);
EEG81=downsample(EEG8, 8);

% order of EEG recorded are PO8, PO7, PO3, PO4, P7, P8, O1 and O2

%compute average EEG power at PO8
PO8 = mean(EEG11.^2);
%compute average EEG power at PO7
PO7 = mean(EEG21.^2);
%compute average EEG power at PO3
PO3 = mean(EEG31.^2);
%compute average EEG power at PO4
PO4 = mean(EEG41.^2);
%compute average EEG power at P7
P7 = mean(EEG51.^2);
%compute average EEG power at P8
P8 = mean(EEG61.^2);
%compute average EEG power at O1
O1 = mean(EEG71.^2);
%compute average EEG power at O2
O2 = mean(EEG81.^2);

% computation of the four ratios

Ratio1= PO8/PO7;
Ratio2= PO3/PO4;
Ratio3= P7/P8;
Ratio4=O1/O2;

Ratios=[Ratio1 Ratio2 Ratio3 Ratio4];

display(Ratios);

figure(1),

plot(EEG2),

hold on;

t=0:1:length(EEG81)-1;
t1= (10/2560) * t;

%plot(t,10*sin(2*pi*100*t),'g');
```

Part B

```
%analysis part 1

load EEG51;
load EEG61;
load EEG71;
```

```
load EEG81;

I1= EEG51;
I2= EEG61;
I3 =EEG71;
I4= EEG81;
figure(1),
%plot(t1,I1, 'b'), hold on;
t=0:1:length(EEG81)-1;
t1= (10/2560)*t;
plot(t1,I2./abs(max(I2)), 'b'); hold on;
%plot(t1,I4, 'r'); hold off;


ylabel ('Amplitude (uV)');
xlabel ('Time (seconds)');
%axis([0 2 -2 2]);

%%%%%
%Coord
Peak1=[1.129 57.55];
Peak2=[1.234 -9.643];
Peak3=[2.004 35.95];
Peak4=[2.18 -26.42];
Peak5=[2.816 21.48];
Peak6=[2.859 -6.705];

tt=0:0.001:2;
f=3; % 10 Hz
y= 0.1*sin(0.7*pi*f*(tt-0.13) + 0.5) + 0.4*cos(1.5*pi*f*(tt-0.13)) - 0.1; % 2 different functions
%y1= 0.2*sin(2*pi*f*tt - 0.2) + 0.25*cos(4*pi*f*tt+0.2) + 0.05*sin(3*pi*f*tt - 0.8) + 0.05*cos(6*pi*f*tt + 0.2) - 0.1;

%figure(2),
plot(tt,y, 'm'); hold off;
%plot(tt,y1,'g'); hold off;
xlabel('Time in seconds');
ylabel('Amplitude');
axis([0 1.0 -1.1 1.1]);


y1=0.1*sin(0.7*pi*f*(tt-0.13));
y2=0.4*cos(1.5*pi*f*(tt-0.13));

figure(2),
plot3(y1,y2,tt);


xt1= sin(tt).*y2;
xt2 = sin(tt).*0.4.*cos((1.5*pi*f + 2).*(tt-0.13));

yt1 = sin(tt).*0.1.*sin(0.7*pi*f*(tt-0.13));
yt2 = sin(tt).*0.1.*sin((0.7*pi*f+2).*(tt-0.13));

zt1= cos(tt);
zt2 = cos(tt);

figure(3),
plot3(xt1, yt1, zt1, xt2, yt2, zt2);
```