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Gas Discharge Visualization (GDV) and results from two pilot studies on the use of computational and visualization models to analyze GDV data

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ABSTRACT

Gas Discharge Visualization (GDV) is a promising real-time non-invasive technique for diagnosing the health of an individual and identifying any potential disorders in their early stages. In this paper, we give a detailed description of the theory behind the GDV technique and the GDV-grams (images of fingertips) that could present unique signature patterns characteristic of specific health disorders. We then present two computational models, developed in our earlier work, to analyze the GDV-grams and illustrate the results from pilot studies obtained using these models. The two models studied are: (i) A quadrant-based visualization and computational model to assess the functional state of human organs and organ systems and its application to Autistic children and (ii) A clustering model to analyze English language anxiety in non-native speakers. The results from the pilot studies have been very encouraging. We conjecture that GDV will be a valuable tool for Medical Biometrics to identify as well as confirm the presence of health disorders at an early stage.

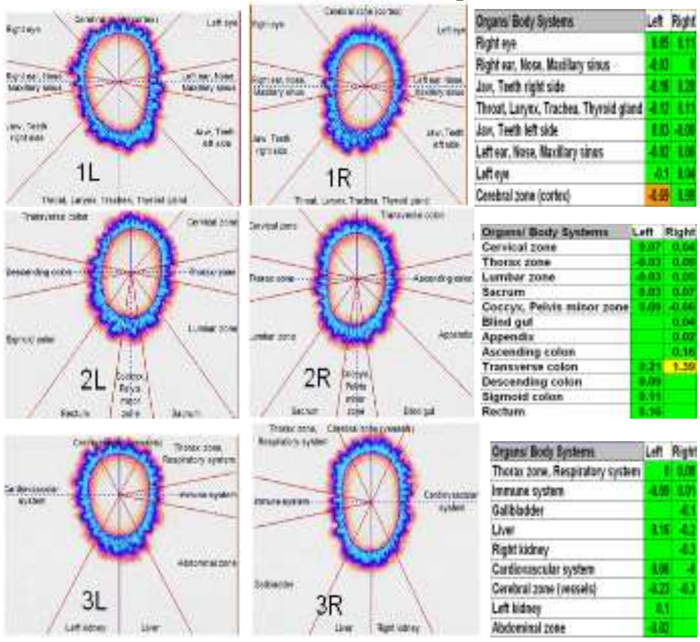
Introduction

Gas Discharge Visualization (GDV)

Gas Discharge Visualization (GDV) [1] is a promising non-invasive technique for diagnosing the functional state of an individual by placing the fingertips on the glass surface of an electro-photonic impulse analyzer. The electro-photonic emission of each of the fingertips, called as GDV-grams, are captured and analyzed in real-time to measure the psycho-emotional and physiological status of the various organs and organ systems of the individual being tested [2]. To collect the physiological parameters of an individual, each of the fingertips need to be kept on a plastic filter placed on the glass surface of the electro-photonic impulse analyzer. The plastic filter prevents direct contact of a fingertip on the electrodes of the analyzer. On the other hand, to collect the psycho-emotional status of an individual, each of the fingertips is directly placed on the glass surface of the electrode of the analyzer, without any intermediate filter. Figure 1 demonstrates a setup of the electro-photonic impulse analyzer operated through a laptop and Figure 2 illustrates the actual procedure of covering the hand with a black cloth to prevent the penetration of light onto the glass surface.

Figure 1: A Setup of the Electro-photonic Impulse Operated through a Laptop

Figure 2: Actual Procedure of Covering the Hand with a Black Cloth for EPE Capture



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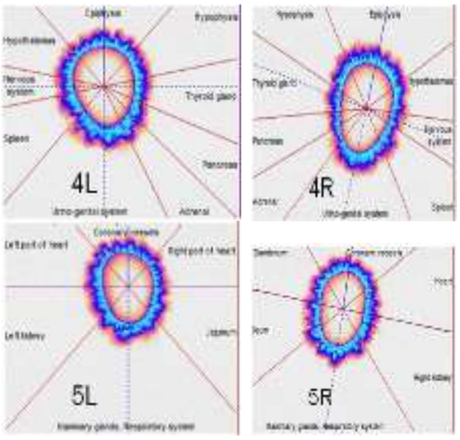

Organs/ Body Systems	Left	Right
Hypophysis	0.17	0.21
Thyroid gland	0.18	0.26
Pancreas	0.23	0.2
Adrenal	0.35	0.14
Urino-genital system	0.22	0.02
Spleen	0.19	0.07
Nervous system	0.23	0.21
Hypothalamus	0.24	0.39
Epiphysis	-0.1	0.07

Organs/ Body Systems	Left	Right
Duodenum		0.32
Ileum		0.62
Mammary glands, Respiratory system	0.32	0.14
Right kidney		0.27
Heart		0.42
Coronary vessels	0.1	-0.02
Left part of heart	0.38	
Left kidney	0.44	
Jejunum	0.41	
Right part of heart	0.3	

Figure 3: GDV-grams of 10-Fingers of Human Hand illustrating the Different Sectors representing the Organ Systems and their Energy Coefficients (L – Left, R – Right)

When the fingertip is placed on a high-intensity electro-magnetic field generated by the electro-photonic impulse analyzer, the photons in the field are excited and the image (i.e., GDV-gram) generated is captured by a camera built-in to the analyzer. Sample snapshots of 10-finger GDV-grams, captured by the GDV camera, illustrating the different sectors representing the organ systems and their associated energy coefficients are displayed in Figure 3. Each of the 10 GDV-grams correspond to a particular fingertip represented as xL or xR where x = 1 (thumb), 2 (index), 3 (middle), 4 (ring), 5 (little); L – Left hand and R – Right hand. The energy coefficient of an organ/ organ system in a GDV-gram is characteristic of the energy state of the organ/ organ system and is obtained by normalizing the image to the standard GDV-grams. The GDV software that computes these numerical energy coefficients has been pre-calibrated with the standard GDV-grams collected from about 10,000 people with normal health. The range of the energy coefficient values for an organ/organ system in normal state is [-0.6, … , 1.0]; whereas, the organs/organ systems with energy coefficient values below -0.6 are said to be hypo-functional (low energy) and organs/organ systems with energy coefficient values greater than 1.0 are said to be hyper-functional (excess energy). In Figure 3, the energy status observed for the organs/organ systems has been visualized by highlighting their energy coefficient values in green, pink and yellow colors – representative of the normal, hypo-functional and hyper-functional states respectively.

Using the energy coefficients obtained from all of the fingertips from the left and right hands, the GDV software constructs a GDV diagram that presents a comprehensive view of the energy states of all the organs/organs systems. The GDV diagram of a person (a sample is shown in Figure 4) is represented using two curves (of red and blue color) and each of these curves is divided into different sectors whose radius correspond to the energy coefficient values observed for the sector. The curve with the red color represents the GDV image taken without using the plastic filter and it captures the functionality of the organs/organ systems characteristic of the psycho-emotional status of an individual. The curve with the blue color represents the GDV image taken using the filter and it captures the functionality of the organs/organ systems characteristic of the physiological status of the individual.

Results from Pilot Studies

In this section, we present results from two pilot studies on GDV: In the first study, we present the results on the use of a quadrant-based visualization and computational model (developed by us in [3] to assess the functional state of human organs/organ systems) when applied on the GDV-grams obtained for an autistic child vs. a non-autistic normal child. In the second study, we present the results on the use of a K-means clustering based computational model (developed by us in [4] to identify unique biological signatures for anxiety in non-native speakers of the English language) when applied on the GDV-grams collected on four international students before and after they took a listening comprehension test.

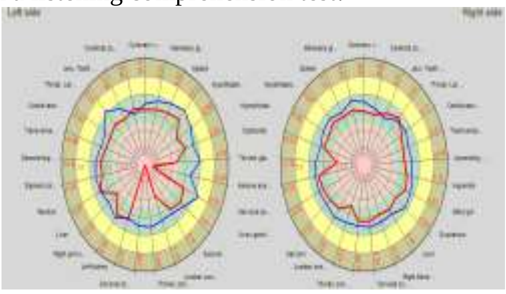

Figure 4: A Sample GDV-diagram obtained using the static GDV-grams of the 10 fingertips

A Quadrant-based Visualization and Computational Model to Assess the Functional State of Human Organs and Organ Systems

Our hypothesis is that if the energy-coefficient obtained using one hand is negative and that obtained using the other hand is positive, it indicates high entropy, characteristic of the abnormality in the functioning of the particular organ/organ system. We plot the energy coefficient values in a Cartesian co-ordinate system, where the X-axis and Y-axis represent the values obtained from the left hand and right hand respectively. If a majority of the data points, each representing an organ/organ system, fall in quadrants II and/or IV, it implies the functional state of the individual is abnormal. We assign a score to each organ/organ system based on the quadrant its data point appears. If a data point appears in quadrant I or III, we assign a score of 1 to the organ/organ system and a score of 0 to the organ/organ system appearing in quadrant II or IV. The overall functionality score for a person is then the sum of the scores assigned to each organ/organ system divided by the number of organs/organ systems considered. If the overall functionality score is above a threshold, we can conclude the functional state of an individual to be normal; otherwise abnormal. Figure 5 presents the algorithm behind the quadrant-based model. Figure 6 presents a 2-D graphical representation of the model applied on autistic child vs. a non-autistic normal child and Figure 7 illustrates the computation of the overall functional score of the two children involved in the studies. The organs/organ systems highlighted in 'red' are abnormal and those in 'green' are normal.

Input: Energy-Coefficients (EC) values of the set of different organs/organ systems O from GDV Electro-photonic capture of the left hand (L) and right hand (R)

Auxiliary Variable: Threshold-Score for classifying the overall functional state

Output: Overall functional state of the human organ system

Model Procedure:

1. Plot the EC_i (L^X, R^Y) values of each organ/organ system $i \in O$ on a Cartesian co-ordinate system

X-axis: EC values for left hand; Y-axis: EC values for right hand

2. For an organ/organ system i,

if (EC_i (L^X, R^Y) ∈Quadrant I OR EC_i (L^X, R^Y) ∈ Quadrant III) then

Functionality_Score$_i$ = 1

if (EC_i (L^X, R^Y) ∈Quadrant II OR EC_i (L^X, R^Y) ∈Quadrant IV) then

Functionality_Score$_i$ = 0

3. Compute Overall Functionality Score = $\frac{\sum_{i \in O} Functionality\_Score_i}{|O|}$

4. If (Overall Functionality Score ≥ Threshold-Score)

return "Normal" state

else

return "Abnormal" state

Figure 5: Algorithm used for the Quadrant-based Visualization and Computational Model

We used a Threshold-Score value of 0.5. The Overall Functionality Score of the autistic child in our experiment is observed to be below this threshold value and the child can be appropriately classified as being "abnormal". The non-autistic child has an Overall Functionality Score far above the threshold value and hence the child can be classified as "normal". The results of the above pilot study indicate that the quadrant-based model can be used to distinguish between a normal healthy person and an abnormal person with one or more health disorders. People with health disorders such as Autism exhibit more entropy with regards to the functional state of their organs.

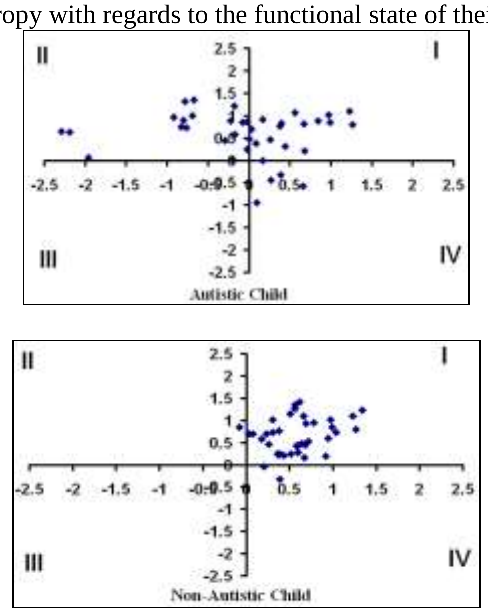

Figure 6: Energy Coefficient Values for Autistic vs. Non-Autistic Child in Cartesian Coordinate System

A Clustering Model to Analyze English Language Anxiety in Non-Native Speakers

The basic idea behind our clustering model is to first compute the average of the absolute difference in the EC values, Δ(EC), for each of the following three categories of the students, before and after a language test: Native English speakers, Indian (Commonwealth country) and Confucian Heritage Cultures (CHC). Our primary hypothesis is that the anxiety level will be different for native English speakers and non-native English speakers. Our secondary hypothesis is that the CHC (Confucian Heritage Culture – Chinese, Japanese, Korean, Vietnamese and etc), Indian (Commonwealth country) and Native English speakers (e.g., African-American students) would respectively have high, moderate and low levels of anxiety with respect to a language task in English.

No.	Organ/Organ System	EC Values: Autistic Child – Left Hand	EC Values: Autistic Child – Right Hand	EC Values: Autistic Child – Functionality Score	EC Values: Non-Autistic Child – Left Hand	EC Values: Non-Autistic Child – Right Hand	EC Values: Non-Autistic Child – Functionality Score
1	Right eye	-0.67	1.34	0	0.66	1.1	1
2	Right ear, Nose, Maxillary sinus	-0.78	1.32	0	0.51	1.14	1
3	Jaw, Teeth right side	-0.52	0.96	0	0.62	1.47	1
4	Throat, Larynx, Trachea, Thyroid gland	-0.18	1.21	0	0.69	0.57	1
5	Jaw, Teeth left side	0.56	1.06	1	0.95	0.59	1
6	Left ear, Nose, Maxillary sinus	0.33	0.31	1	0.95	0.6	1
7	Left eye	0.22	0.98	0	0.28	0.54	1
8	Cerebral zone (cortex)	-0.68	0.99	0	0.31	0.73	1
9	Cervical zone	-2.29	0.65	0	0.27	0.65	1
10	Thorax zone	-2.19	0.63	0	0.18	0.58	1
11	Lumbar zone	-0.82	0.96	0	0.31	1.02	1
12	Sacrum	0.09	0.38	1	0.56	1.27	1
13	Coccyx, Pelvis minor zone	-0.02	0.24	0	0.56	1.35	1
14	Transverse colon	-0.03	0.75	0	0.08	0.7	1
15	Thorax zone, Respiratory system	0.76	0.72	0	0.36	0.25	1
16	Immune system	-0.8	0.5	0	0.39	0.24	1
17	Liver	-1.96	0.96	0	0.92	0.2	1
18	Cardiovascular system	0.67	0.81	1	0.37	0.23	1
19	Cerebral zone (vessels)	0.05	0.88	1	0.21	-0.01	0
20	Hypophysis	-0.17	0.57	0	0.6	0.27	1
21	Thyroid gland	0	0.89	1	0.52	0.25	1
22	Pancreas	0.66	0.57	0	0.67	0.16	1
23	Adrenal	0.68	0.21	1	0.68	0.45	1
24	Urino-genital system	-0.25	0.44	0	0.72	0.53	1
25	Spleen	0.1	-0.94	0	0.61	0.47	1
26	Nervous system	0.27	-0.45	0	0.61	0.44	1
27	Hypothalamus	0.17	-0.01	0	0.58	0.43	1
28	Epiphysis	-0.2	0.01	0	0.41	0.21	1
29	Mammary glands, Respiratory system	0.17	0.31	1	1.34	1.23	1
30	Coronary vessels	0.4	0.82	1	1.01	0.73	1
	Overall Functionality Score	9/30 = 0.33			29/30 = 0.97		

Figure 7: Computation of the Overall Functionality Score using the Quadrant-based Model

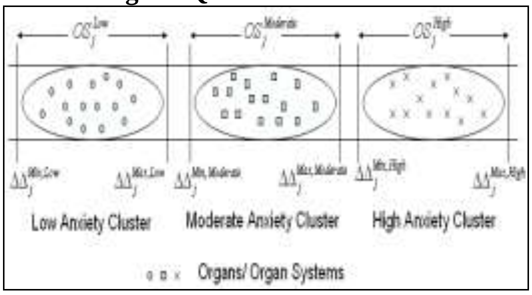

Figure 8: Grouping of the Organs/Organ Systems into Low, Moderate and High Clusters and the Corresponding Range of ΔΔ Values

Using the average Δ(EC) values for native English speakers as the baseline, we compute the relative absolute difference, ΔΔ(EC), in the energy coefficient values for the CHC group and the Indians. We run the K-Means clustering algorithm on a ΔΔ superset comprising of ΔΔ(EC) values obtained for the different organs/organ systems for the CHC group and the Indian students and classify these values to three different clusters representing organs/organ systems that have low, moderate and high impact due to English language anxiety. The corresponding range of the ΔΔ(EC) values are the biological signatures for anxiety of non-native English speakers with respect to any particular language activity and can be used as benchmarks to classify a test subject as having low, moderate or high levels of English language anxiety (refer Figure 8). More details about the theory behind the clustering model can be found in [4].

Four international students (One Chinese, One Turkish and Two Vietnamese) at the English as a Second Language Institute (ELSI) at Jackson State University volunteered to participate in our pilot study. We chose to initially study auditory comprehension anxiety because of our conjecture that listening skill is the hardest to master in second language learning. All the students were enrolled in the medium level of English as a Second Language course at ELSI. The students signed the consent form in compliance with the human Institutional Review Board (IRB) and the purpose of the procedure was explained to them according to the guidelines of the human IRB. We recorded two sets of static GDV-grams around the students' fingertips, one before and one after the listening comprehension tasks. The recording of the images was done without and with filter. Tables 1 (psycho-emotional level) and 2 (physiological level) respectively show the Energy Coefficient values obtained from the four students, without and with the use of filter. Tables 3 (Psycho-emotional level) and 4 (Physiological level) show the average Δ(EC) values for the four student participants and the clustering of the organs/organ systems into clusters of low, moderate and high English language anxiety using the K-means clustering algorithm [5].

The magnitude of the range of the average(Δ(EC)) values in Tables 3 and 4 indicate that the psycho-emotional status (rather than the physiological status) of an individual is more affected due to language anxiety. The maximum average(Δ(EC)) value obtained for the high anxiety cluster in GDV-grams collected with filter (i.e., at the physiological level) falls in the range of average(Δ(EC)) values delineated for low anxiety cluster in GDV-grams collected without filter (i.e., at the psycho-emotional level). The validity of the clustering model is also vindicated by the presence of the Nervous system and organs such as the Thyroid gland and Spleen (all known to be hyper-functional when an individual is overactive at the psycho-emotional level) in the High anxiety cluster of GDV-grams obtained without filter. In the near future, we will be collecting more GDV data involving students belonging to all the three groups (African-Americans, Indians and CHC group) considered for the computational model. Taking cue from the results of the pilot study, we anticipate the average of the ΔΔ(EC)) values at the physiological level will be closer to zero. Hence, we will only consider the average of the Δ(EC) values obtained at the psycho-emotional level to compute the average ΔΔ(EC) values for classifying the organs/organ systems into clusters of low, moderate and high impact due to English language anxiety.

Conclusions and Future Research

The Gas Discharge Visualization (GDV) technique is rapidly getting wide recognition owing to its non-invasive nature and ability to offer a real-time early diagnosis of the status of the organs and organ systems affected with any health disorder. It is very essential to develop computational models that can analyze as well as visualize the data collected using GDV. The results from our two pilot studies are very encouraging. A natural extension of the above work on GDV would be to gather more such GDV-grams of people affected with specific health disorders and use the unique signature patterns observed through the computational and visualization models for each of these disorders to predict the presence of such a disorder in individuals who have not been yet diagnosed so. In this context, GDV can become a valuable tool for Medical Biometrics [6] and can be used as a primary tool for diagnosis, referred to as validation (i.e., identifying the disorder) and/or as a complementary tool for diagnosis, referred to as verification (confirming the presence of the disorder identified using another primary tool). The effectiveness of the computational and visualization models lies in minimizing the number of false positives (predicting a health disorder when it actually does not exist) and number of false negatives (not predicting a health disorder that actually exists). As we gather more GDV-grams and train our models, we will be able to evaluate the effectiveness of the models with respect to the false positives and false negatives.

Acknowledgments

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Table 1: Energy-Coefficient Values of Student Participants before and after the Language Task (at the Psycho-emotional Level – without the use of filter)

Organs/Organ Systems	S1-before	S1-after	Δ-1	S2-before	S2-after	Δ-2	S3-before	S3-after	Δ-3	S4-before	S4-after	Δ-4	avg(Δ)
Right eye	-0.36	-0.21	0.15	0.01	0.02	0.01	-1.29	0.27	1.56	0.1	-0.3	0.4	0.53
Right ear, Nose, Maxillary sinus	-0.57	-0.51	0.06	0.06	0.1	0.04	-1.07	0.14	1.21	0.09	-0.23	0.32	0.408
Jaw, Teeth right side	-1.7	-0.25	1.45	0.1	0.03	0.07	-1.19	0.42	1.61	-0.05	0	0.05	0.795
Throat, Larynx, Trachea, Thyroid gland	-1.22	-0.68	0.54	0.13	0.08	0.05	0.64	1.06	0.42	0.02	-0.24	0.26	0.318
Jaw, Teeth left side	-0.56	-1.71	1.15	0.25	0	0.25	1.05	0.24	0.81	0.2	-0.49	0.69	0.725
Left ear, Nose, Maxillary sinus	-0.29	-1.03	0.74	0.15	-0.03	0.18	0.69	0.03	0.66	0.3	-0.24	0.54	0.53
Left eye	-0.43	-0.44	0.01	0.09	-0.04	0.13	0.98	0.25	0.73	0.35	-0.15	0.5	0.343
Cerebral zone (cortex)	-0.36	-0.69	0.33	-0.09	-0.22	0.13	0.13	0.38	0.25	-0.34	-0.51	0.17	0.22
Cervical zone	0.04	-0.35	0.39	0.17	0.16	0.01	-0.17	-0.08	0.09	0.37	-0.14	0.51	0.25
Thorax zone	-0.5	0.05	0.55	0.18	0.23	0.05	-0.29	0.17	0.46	0.59	-0.14	0.73	0.448
Lumbar zone	-0.27	-0.31	0.04	0.31	0.22	0.09	-0.24	0.17	0.41	0.39	-0.03	0.42	0.24
Sacrum	-0.03	-0.41	0.38	0.48	0.39	0.09	-0.26	0.15	0.41	0.31	0	0.31	0.298
Coccyx, Pelvis minor zone	-0.33	-0.7	0.37	0.43	0.48	0.05	-1.47	0.35	1.82	0.17	0.08	0.09	0.583
Transverse colon	-0.07	-0.56	0.49	0.05	0.07	0.02	-0.65	0.12	0.77	-0.06	-0.3	0.24	0.38
Thorax zone, Respiratory system	0.09	-0.28	0.37	0.27	0.07	0.2	-0.15	0.04	0.19	0.13	0.06	0.07	0.208
Immune system	-0.02	-0.19	0.17	0.23	0.07	0.16	-0.83	-0.07	0.76	0.14	-0.28	0.42	0.378
Liver	-0.63	-0.83	0.2	0.47	0.38	0.09	0.04	0.05	0.01	-0.75	-0.12	0.63	0.233
Cardiovascular system	-0.84	-0.89	0.05	0.2	0.08	0.12	-0.27	0.06	0.33	0.07	-0.04	0.11	0.153
Cerebral zone (vessels)	-0.13	-0.5	0.37	0.05	-0.05	0.1	-0.66	-0.29	0.37	-0.02	-0.24	0.22	0.265
Hypophysis	0.03	-0.36	0.39	0.3	0.16	0.14	-0.32	0	0.32	0.06	0	0.06	0.228
Thyroid gland	0.11	-0.34	0.45	0.26	0.19	0.07	-1.58	0.13	1.71	0.22	-0.03	0.25	0.62
Pancreas	-0.15	-0.29	0.14	0.3	0.11	0.19	-1.3	0.07	1.37	0.1	-0.11	0.21	0.478
Adrenal	-0.37	-0.4	0.03	0.44	0.26	0.18	-0.52	0.01	0.53	-0.2	-0.12	0.08	0.205
Urino-genital system	-1.63	-0.32	1.31	0.47	0.33	0.14	-0.02	-0.02	0	-0.08	-0.37	0.29	0.435
Spleen	-1.55	-0.24	1.31	0.33	0.11	0.22	0.01	0.06	0.05	0.09	-0.74	0.83	0.603
Nervous system	-1.6	0.15	1.75	0.26	0.22	0.04	-0.1	0.15	0.25	0.2	-0.36	0.56	0.65
Hypothalamus	-0.32	0.35	0.67	0.34	0.16	0.18	-0.33	0.08	0.41	0.23	-0.09	0.32	0.395
Epiphysis	-0.32	-0.16	0.16	0.1	0.02	0.08	-0.34	-0.16	0.18	-0.03	-0.39	0.36	0.195
Mammary glands, Respiratory system	-0.07	0.14	0.21	0.66	0.66	0	0.33	0.55	0.22	0.31	0.14	0.17	0.15
Coronary vessels	0.13	0.1	0.03	0.22	0.2	0.02	0.05	0.15	0.1	0.13	-0.26	0.39	0.135

Table 2: Energy-Coefficient Values of Student Participants before and after the Language Task (at the Physiological Level – with the use of filter)

Organs/Organ Systems	S1-before	S1-after	Δ-1	S2-before	S2-after	Δ-2	S3-before	S3-after	Δ-3	S4-before	S4-after	Δ-4	avg(Δ)
Right eye	0.14	0.06	0.08	0.32	0.14	0.18	0.35	0.42	0.07	0.2	0.14	0.06	0.098
Right ear, Nose, Maxillary sinus	0.16	-0.03	0.19	0.34	0.25	0.09	0.53	0.55	0.02	0.28	0.26	0.02	0.08
Jaw, Teeth right side	0.21	0	0.21	0.53	0.34	0.19	0.69	0.75	0.06	0.39	0.35	0.04	0.125
Throat, Larynx, Trachea, Thyroid gland	-0.07	0.12	0.19	0.47	0.44	0.03	0.79	1.13	0.34	0.2	0.26	0.06	0.155
Jaw, Teeth left side	-0.05	0.13	0.18	0.37	0.41	0.04	0.67	0.89	0.22	0.37	0.13	0.24	0.17
Left ear, Nose, Maxillary sinus	-0.01	0.13	0.14	0.33	0.33	0	0.69	0.77	0.08	0.4	0.09	0.31	0.133
Left eye	0.02	0.11	0.09	0.19	0.32	0.13	0.82	0.74	0.08	0.39	0.24	0.15	0.113
Cerebral zone (cortex)	-0.15	-0.15	0	0.1	0.02	0.08	0.38	0.49	0.11	-0.11	-0.14	0.03	0.055
Cervical zone	0.15	0.26	0.11	0.45	0.27	0.18	0.28	0.21	0.07	0.5	0.24	0.26	0.155
Thorax zone	0.24	0.26	0.02	0.54	0.36	0.18	0.28	0.22	0.06	0.65	0.26	0.39	0.163
Lumbar zone	0.18	0.21	0.03	0.64	0.38	0.26	0.3	0.28	0.02	0.59	0.33	0.26	0.143
Sacrum	0.21	0.08	0.13	0.73	0.53	0.2	0.35	0.33	0.02	0.69	0.39	0.3	0.163
Coccyx, Pelvis minor zone	0.2	0.07	0.13	0.83	0.63	0.2	0.31	0.36	0.05	0.6	0.38	0.22	0.15
Transverse colon	0.05	0.06	0.01	0.38	0.06	0.32	0.06	0.04	0.02	0.27	0.07	0.2	0.138
Thorax zone, Respiratory system	0.2	0.3	0.1	0.61	0.28	0.33	0.36	0.12	0.24	0.41	0.28	0.13	0.2
Immune system	0.22	0.21	0.01	0.66	0.31	0.35	0.38	0.23	0.15	0.44	0.28	0.16	0.168
Liver	0.1	0.16	0.06	0.76	0.59	0.17	0.41	0.29	0.12	0.51	0.31	0.2	0.138
Cardiovascular system	0.14	0.17	0.03	0.58	0.35	0.23	0.46	0.18	0.28	0.45	0.21	0.24	0.195
Cerebral zone (vessels)	0.03	0	0.03	0.51	0.13	0.38	0.09	-0.15	0.24	0.08	-0.08	0.16	0.203
Hypophysis	0.19	0.29	0.1	0.53	0.38	0.15	0.3	0.32	0.02	0.44	0.34	0.1	0.093
Thyroid gland	0.24	0.23	0.01	0.49	0.45	0.04	0.31	0.26	0.05	0.44	0.44	0	0.025
Pancreas	0.19	0.24	0.05	0.55	0.5	0.05	0.29	0.21	0.08	0.5	0.51	0.01	0.048
Adrenal	0.19	0.28	0.09	0.56	0.51	0.05	0.37	0.28	0.09	0.51	0.47	0.04	0.068
Urino-genital system	0.01	0.07	0.06	0.61	0.58	0.03	0.37	0.33	0.04	0.39	0.29	0.1	0.058
Spleen	0	0.2	0.2	0.45	0.38	0.07	0.24	0.34	0.1	0.34	0.2	0.14	0.128
Nervous system	0.25	0.32	0.07	0.38	0.36	0.02	0.26	0.35	0.09	0.38	0.28	0.1	0.07
Hypothalamus	0.37	0.33	0.04	0.3	0.32	0.02	0.45	0.35	0.1	0.5	0.39	0.11	0.068
Epiphysis	0.02	0.07	0.05	0.33	0.17	0.16	0.14	0.05	0.09	0.04	0.13	0.09	0.098
Mammary glands, Respiratory system	0.36	0.41	0.05	0.83	0.8	0.03	0.83	0.7	0.13	0.49	0.57	0.08	0.073
Coronary vessels	0.34	0.29	0.05	0.42	0.37	0.05	0.45	0.41	0.04	0.15	0.2	0.05	0.048

Table 3: Clustering of the Organs/Organ Systems at the Psycho-emotional Level

Organs/Organ Systems	Δ-1	Δ-2	Δ-3	Δ-4	avg(Δ(EC))
Coronary vessels	0.03	0.02	0.1	0.39	0.135
Mammary glands, Respiratory system	0.21	0	0.22	0.17	0.15
Cardiovascular system	0.05	0.12	0.33	0.11	0.1525
Epiphysis	0.16	0.08	0.18	0.36	0.195
Adrenal	0.03	0.18	0.53	0.08	0.205
Thorax zone, Respiratory system	0.37	0.2	0.19	0.07	0.2075
Cerebral zone (cortex)	0.33	0.13	0.25	0.17	0.22
Hypophysis	0.39	0.14	0.32	0.06	0.2275
Liver	0.2	0.09	0.01	0.63	0.2325
Lumbar zone	0.04	0.09	0.41	0.42	0.24
Cervical zone	0.39	0.01	0.09	0.51	0.25
Cerebral zone (vessels)	0.37	0.1	0.37	0.22	0.265
Sacrum	0.38	0.09	0.41	0.31	0.2975
Throat, Larynx, Trachea, Thyroid gland	0.54	0.05	0.42	0.26	0.3175
Left eye	0.01	0.13	0.73	0.5	0.3425
Immune system	0.17	0.16	0.76	0.42	0.3775
Transverse colon	0.49	0.02	0.77	0.24	0.38
Hypothalamus	0.67	0.18	0.41	0.32	0.395
Right ear, Nose, Maxillary sinus	0.06	0.04	1.21	0.32	0.4075
Urino-genital system	1.31	0.14	0	0.29	0.435
Thorax zone	0.55	0.05	0.46	0.73	0.4475
Pancreas	0.14	0.19	1.37	0.21	0.4775
Right eye	0.15	0.01	1.56	0.4	0.53
Left ear, Nose, Maxillary sinus	0.74	0.18	0.66	0.54	0.53
Coccyx, Pelvis minor zone	0.37	0.05	1.82	0.09	0.5825
Spleen	1.31	0.22	0.05	0.83	0.6025
Thyroid gland	0.45	0.07	1.71	0.25	0.62
Nervous system	1.75	0.04	0.25	0.56	0.65
Jaw, Teeth left side	1.15	0.25	0.81	0.69	0.725
Jaw, Teeth right side	1.45	0.07	1.61	0.05	0.795

Range of average(Δ(EC)) values	Cluster Type
[0.135 .... 0.318]	Low Anxiety Cluster
[0.343 .... 0.53]	Moderate Anxiety Cluster
[0.583 .... 0.795]	High Anxiety Cluster

Table 4: Clustering of the Organs/ Organ Systems at the Physiological Level

Organs/Organ Systems	Δ-1	Δ-2	Δ-3	Δ-4	avg(Δ(EC))
Thyroid gland	0.01	0.04	0.05	0	0.025
Pancreas	0.05	0.05	0.08	0.01	0.0475
Coronary vessels	0.05	0.05	0.04	0.05	0.0475
Cerebral zone (cortex)	0	0.08	0.11	0.03	0.055
Urino-genital system	0.06	0.03	0.04	0.1	0.0575
Adrenal	0.09	0.05	0.09	0.04	0.0675
Hypothalamus	0.04	0.02	0.1	0.11	0.0675
Nervous system	0.07	0.02	0.09	0.1	0.07
Mammary glands, Respiratory system	0.05	0.03	0.13	0.08	0.0725
Right ear, Nose, Maxillary sinus	0.19	0.09	0.02	0.02	0.08
Hypophysis	0.1	0.15	0.02	0.1	0.0925
Right eye	0.08	0.18	0.07	0.06	0.0975
Epiphysis	0.05	0.16	0.09	0.09	0.0975
Left eye	0.09	0.13	0.08	0.15	0.1125
Jaw, Teeth right side	0.21	0.19	0.06	0.04	0.125
Spleen	0.2	0.07	0.1	0.14	0.1275
Left ear, Nose, Maxillary sinus	0.14	0	0.08	0.31	0.1325
Transverse colon	0.01	0.32	0.02	0.2	0.1375
Liver	0.06	0.17	0.12	0.2	0.1375
Lumbar zone	0.03	0.26	0.02	0.26	0.1425
Coccyx, Pelvis minor zone	0.13	0.2	0.05	0.22	0.15
Throat, Larynx, Trachea, Thyroid gland	0.19	0.03	0.34	0.06	0.155
Cervical zone	0.11	0.18	0.07	0.26	0.155
Thorax zone	0.02	0.18	0.06	0.39	0.1625
Sacrum	0.13	0.2	0.02	0.3	0.1625
Immune system	0.01	0.35	0.15	0.16	0.1675
Jaw, Teeth left side	0.18	0.04	0.22	0.24	0.17
Cardiovascular system	0.03	0.23	0.28	0.24	0.195
Thorax zone, Respiratory system	0.1	0.33	0.24	0.13	0.2
Cerebral zone (vessels)	0.03	0.38	0.24	0.16	0.2025

Range of average(Δ(EC)) values	Cluster Type
[0.025 .... 0.08]	Low Anxiety Cluster
[0.0925 .... 0.1425]	Moderate Anxiety Cluster
[0.15 .... 0.2025]	High Anxiety Cluster