Communication

Autism from a Biometric Perspective

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Abstract: *Purpose*: The aim of this pilot study was to test autistic children, siblings and their parents using a biometric device based on the gas discharge visualization (GDV) technique in order to assess their psycho-emotional and physiological functional state based on the activity of the autonomic nervous system. *Hypothesis*: We hypothesize that the biometric assessment based on GDV will enable us: (1) to evaluate some specific features associated with autism spectrum disorder (ASD) as well as to compare autistic children to their siblings and to controls; (2) to analyze the differences in individual values of parents of autistic children *versus* parents of normal children. *Results*: Out of total of 48 acupuncture points present on ten fingertips of both hands and associated to organs/organ systems, autistic children differed significantly from controls (p < 0.05) in 36 (images without filter) and 12 (images with filter), siblings differed significantly from controls (p < 0.05) in 12 (images without filter) and seven (images with filter), autistic children differed significantly (p < 0.05) from siblings in eight (images without filter) and one (images with filter), fathers of autistic children differed significantly (p < 0.05) from controls in 14 (images without filter) and three (images with filter) and mothers of autistic children differed significantly (p < 0.05) from controls in five (images without filter) and

nine (images with filter) acupuncture points. *Conclusions*: All compared groups have shown significant difference on both psycho-emotional (images without filter) and physiological (images with filter) levels. However, the differences between autistic children and controls expressed on psycho-emotional level were the most significant as compared to the other groups. Therefore, the activity of the sympathetic autonomic nervous system is significantly altered in children with autism. The biometric method based on GDV is a promising step in autism research that may lead towards creating a disease profile and identify unique signature/biomarker for autism. Further work should involve more participants in order to augment our findings.

**Keywords:** autism; biometric evaluation; electro-photonic emission; gas discharge visualization (GDV)

1. Introduction

According to the United States Department of Developmental Services, the prevalence of autism spectrum disorders increased 556% from 1991 to 1997 [1]. One in every eight boys is diagnosed with autism, and boys are four times more likely to be affected by this disease than girls. Also, one out of every sixty-eight families has a child with autism. Incidences of autism are increasing by 3.8% per year worldwide and by 15% in the USA [1]. The common signs of autism are marked by: (1) qualitative impairment in social interaction; (2) qualitative impairments in communication; (3) restricted repetitive and stereotyped patterns of behavior. Autism covers a continuum of disorders beginning from mild autism and Asperger's Syndrome to severe autism. Autism Spectrum Disorder is defined only behaviorally, which often contributes to the heterogeneity of cohort studies. Factors such as age, gender, IQ, and behavioral traits often diverge considerably, with non-uniform matching of controls.

The six autistic participants, their parents, siblings and control groups were tested using biometric device based on gas discharge visualization (GDV). It is a non-invasive imaging technique used to assess the functional state of human body by recording the responses of the autonomic nervous system to a high intensity electromagnetic field using fingertips. The method is based on acupuncture approach, where organs and organ systems are connected by electron communication. The classification of acupuncture points for GDV has been developed by Mandel and Korotkov and is presented in Figure 1. The respective sectors of the fingertips correspond to specific organs/organ systems including the immune, respiratory, digestive, cardiovascular, central nervous, peripheral nervous, urino-genital, and endocrine systems [2-6].

The aim of our pilot study was to compare autistic individuals with controls and non-autistic siblings as well as to compare their parents with parents who do not have autistic children and analyze statistically the obtained results for possible common difference regarding particular acupuncture regions present on the fingertips.

Figure 1. Division of images into sectors after Korotkov K.G.
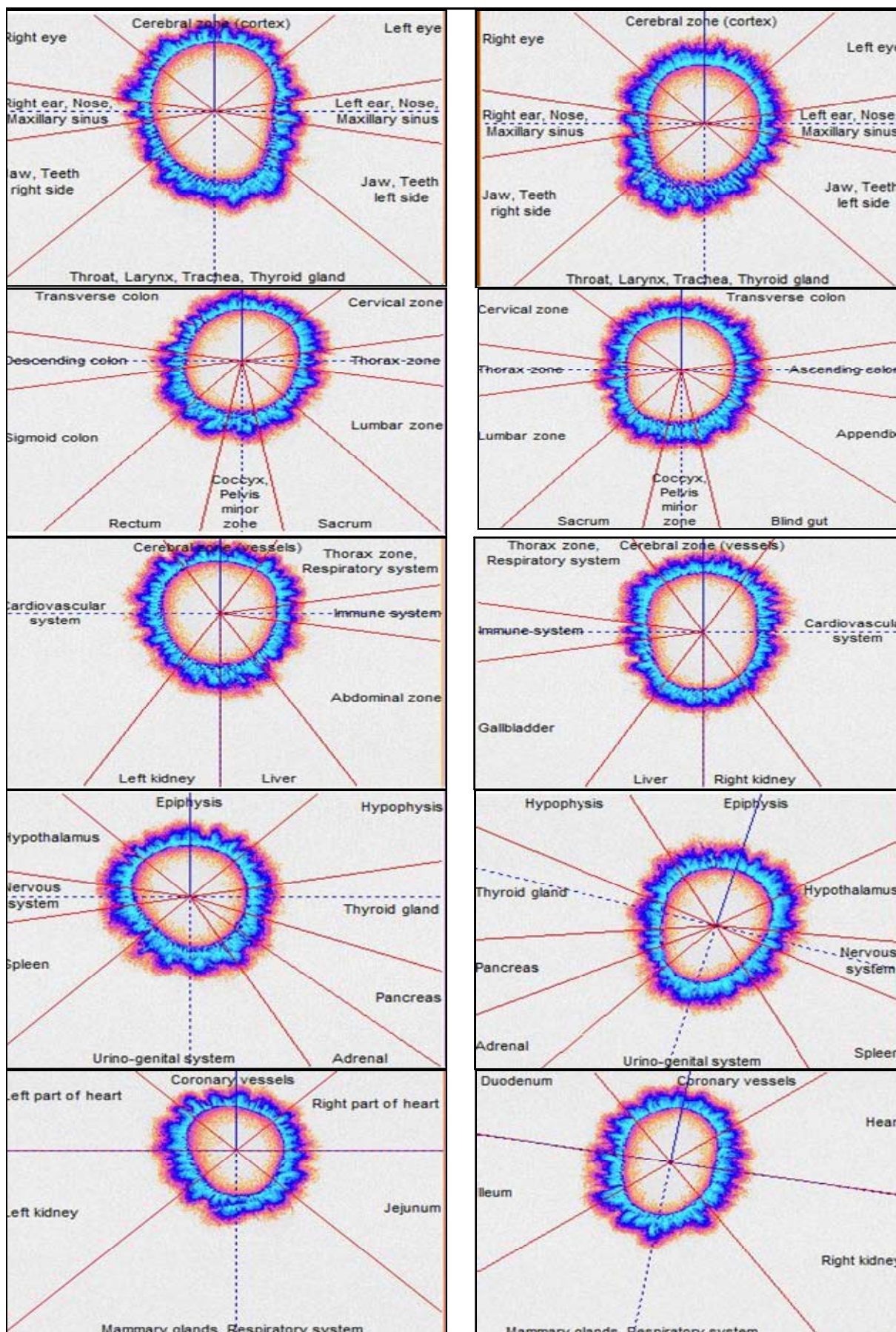
2. Experimental Section

A. *The Institutional Review Board (IRB) Approval*

The IRB approval of the consent form was obtained according to the guidelines prescribed by the Review Board at Jackson State University. All participants were residents of Mississippi. The participants of the study and their parents signed a consent form where they agreed that the results of the study may be used for publication or teaching purposes.

B. *Participants*

The autistic children in this study were previously diagnosed with mild autism and/or Asperger's Syndrome. The screenings of autistic children were done randomly. However, the age of the autistic children fell into a range of five to twelve years old, 9.3 being the mean age. The mean age of the control group was the same. Control group for children category had two males and five females. Control groups for mothers and fathers of autistic children were selected randomly from the database of electro-photonic emission of human fingertips of healthy individuals.

C. *Equipment, Software, and Procedure*

The study was conducted using a biometric device based on GDV "GDV Compact". To reduce the barrier of a new setting for autistic children, parents were asked to participate first. Each participant was asked to place each finger correctly on a glass surface. The images of the electro-photonic emissions of all ten fingertips were taken twice. First, we recorded the response of the sympathetic nervous system, which was measured using the properties of electrical conductance of skin in high intensity electromagnetic field. Second, to assess the physiological state of autistic individuals and their parents, we used thin plastic film to separate skin from direct contact with the glass surface thereby enabling recording of the response of the parasympathetic nervous system.

The image of each fingertip is captured individually as a single snapshot with an optical camera that is placed underneath the glass surface on which the participant puts each finger. Under a high intensity electromagnetic field, the finger emits a burst of electrons and photons and electro-photonic emissions are transformed into video-signals, which are recorded in the form of single snapshots or fingertip images called GDV-grams. The data processor utilizes a specialized software complex that permits the calculation of the system parameters. The software GDV Diagram facilitates the implementation of standardized processing of GDV-images. The process involves capturing and filtering GDV-images, obtaining numerical values, creating graphs and diagrams, and saving data as well as transferring data for additional processing.

D. *Statistical Analysis*

SAS software was used for statistical analysis of the obtained data, specifically General Linear Model Procedure including Tukey's and Duncan's tests.

3. Results

The results of the screening of autistic individuals, their parents and siblings as well as control groups are presented graphically in Table 1, Table 2, and Table 3. Five groups were compared: (1) autistic children and controls (marked with green color) (Table 1), (2) siblings from the families with autistic children and controls (marked with blue color) (Table 2), (3) autistic children and siblings (marked with yellow color) (Table 2), (4) fathers of autistic children and controls (marked with grey color) (Table 3), (5) mothers of autistic children and controls (marked with pink color) (Table 3). The comparison of captures without filter and with filter within mentioned groups was done on the level of individual values assigned to the specific acupuncture regions of fingertips. Out of total of 48 acupuncture points present on ten fingertips of both hands and associated to organs/organ systems, autistic children differed significantly from controls ($p < 0.05$) in 36 (images without filter) and 12 (images with filter), siblings differed significantly from controls ($p < 0.05$) in 12 (images without filter) and seven (images with filter), autistic children differed significantly ($p < 0.05$) from siblings in eight (images without filter) and one (images with filter), fathers of autistic children differed significantly ($p < 0.05$) from controls in 14 (images without filter) and three (images with filter) and mothers of autistic children differed significantly ($p < 0.05$) from controls in five (images without filter) and nine (images with filter) acupuncture points.

Table 1. Statistically significant difference ($p < 0.05$) of organs within the groups of autistic children *vs.* control.

Autistic children *vs.* Controls					
Organs/Organ systems	**F0**	**F1**	**Organs/Organ systems**	**F0**	**F1**
Right eye	■		**Cardiovascular system**	■	
Right ear, Nose, Maxillary sinus	■	■	**Cerebral zone (vessels)**	■	
Jaw, Teeth right side	■	■	**Abdominal zone**	■	
Throat, Larynx, Trachea, Thyroid gland	■	■	**Hypophysis**	■	
Jaw, Teeth left side	■		**Thyroid gland**	■	
Left ear, Nose, Maxillary sinus	■		**Pancreas**	■	■
Left eye	■	■	**Adrenal**	■	
Cerebral zone (cortex)	■		**Urino-genital system**	■	
Thorax zone	■		**Spleen**	■	■
Lumbar zone	■	■	**Nervous system**	■	
Coccyx, Pelvis minor zone	■		**Epiphysis**	■	
Blind gut	■		**Duodenum**	■	
Appendix	■		**Ileum**	■	■
Ascending colon	■		**Mammary glands, Respiratory system**	■	
Transverse colon	■		**Jejunum**	■	■
Descending colon	■		**Right part of heart**		■
Thorax zone, Respiratory system	■		**Activation coefficient**	■	
Immune system	■		**Integral area**	■	
Gallbladder	■		**RMS of Integral area**	■	
Liver	■				

*F0 and F1 are measurement without and with the filter. Green highlights indicate P < 0.05.

Table 2. Statistically significant difference (p < 0.05) of organs within groups of siblings *vs*. normal children and autistic children *vs*. siblings.

Organs/Organ systems	Siblings *vs*. control group		Autistic group *vs*. siblings	
	F0	F1	F0	F1
Right eye		cyan		
Throat, Larynx, Trachea, Thyroid gland			yellow	
Jaw, Teeth left side	cyan			
Thorax zone	cyan			
Lumbar zone	cyan	cyan		
Sacrum				
Coccyx, Pelvis minor zone		cyan		
Appendix	cyan			
Ascending colon	cyan			
Descending colon			yellow	
Gallbladder	cyan			
Liver	cyan		yellow	
Left kidney			yellow	
Abdominal zone			yellow	
Hypophysis			yellow	
Thyroid gland		cyan		
Pancreas	cyan			
Urino-genital system			yellow	
Spleen	cyan			
Nervous system	cyan			
Hypothalamus		cyan		
Epiphysis	cyan			
Mammary glands, Respiratory system		cyan	yellow	yellow
Jejunum	cyan	cyan		
Activation coefficient	cyan	cyan	yellow	yellow
Integral area			yellow	
Integral entropy		cyan		

*F0 and F1 are measurements with and without the filter. Cyan and yellow highlights indicate P < 0.05.

Table 3. Statistically significant difference (p < 0.05) of organs within groups of fathers *vs.* control and mothers *vs.* control.

Organs/Organ systems	Fathers *vs.* fathers control			Mothers *vs.* mothers control		
	F0	F1		F0	F1	
Right eye				orange	orange	
Right ear, Nose, Maxillary sinus				orange		
Throat, Larynx, Trachea, Thyroid gland		grey		orange		
Jaw, Teeth left side					orange	
Left ear, Nose, Maxillary sinus	grey				orange	
Left eye	grey			orange	orange	
Cervical zone					orange	
Thorax zone	grey				orange	
Sacrum	grey					
Coccyx, Pelvis minor zone	grey					
Blind gut	grey					
Appendix	grey					
Immune system	grey					
Right kidney	grey					
Abdominal zone				orange		
Thyroid gland	grey					
Pancreas					orange	
Hypothalamus	grey					
Epiphysis	grey			orange		
Mammary glands, Respiratory system	grey	grey				
Heart	grey	grey				
Right part of heart				orange		

*F0 and F1 are measurements without and with the filter. Grey and Orange highlights indicate P < 0.05.

The statistical analysis of data of autistic children *versus* controls in Table 1. (images without filter) has demonstrated statistically significant difference (p < 0.05) for the acupuncture regions corresponding to right eye, right ear, nose, maxillary sinus, jaw and teeth right side, throat, trachea, larynx, thyroid gland, jaw and teeth left side, left ear, left eye, cerebral cortex, thorax zone, lumbar zone, coccyx, pelvis minor zone, blind gut, appendix, ascending colon, transverse colon, descending colon, mammary glands and respiratory system, immune system, liver, cardiovascular system, cerebral vessels, abdominal zone, hypophysis, thyroid, pancreas, adrenal gland, urino-genital system, spleen, nervous system, epiphysis, duodenum, ileum and jejunum. Analysis of the images with filter pointed out statistically significant difference (p < 0.05) for acupuncture regions corresponding to right ear, nose, maxillary sinus, jaw and teeth right side, throat, larynx, trachea, thyroid gland, left eye, lumbar zone, pancreas, spleen, nervous system, ileum, jejunum and right part of heart.

Also, significantly different (p < 0.05) were integral parameters of autonomic tone (activation coefficient) and area of electro-photonic emission (images without filter) (Table 1).

Comparison of siblings with controls (Table 2) showed statistical significance (p < 0.05) of following variables (images without filter): jaw and teeth left side, thorax zone, lumbar zone,

appendix, ascending colon, gallbladder, liver, pancreas, spleen, nervous system, epiphysis and jejunum. Statistical analysis of data obtained from the images with filter indicate significant difference ($p < 0.05$) for right eye, lumbar zone, coccyx, pelvis minor zone, thyroid gland, hypothalamus, mammary glands and respiratory system and jejunum.

Also, significantly different ($p < 0.05$) were integral parameters of autonomic tone (activation coefficient) and entropy of electro-photonic emission (images with filter) (Table 2).

Within groups of autistic children and siblings (Table 2) statistically significant ($p < 0.05$) difference was found for acupuncture regions corresponding to throat, larynx, trachea, thyroid gland, descending colon, liver, left kidney, abdominal zone, hypophysis, urino-genital, mammary glands and respiratory system (images without filter) and mammary glands and respiratory system (images with filter).

Also, significantly different ($p < 0.05$) were integral parameters of autonomic tone (activation coefficient) and area of electro-photonic emission (images without filter) (Table 2).

Fathers of autistic children *versus* control group (Table 3) exhibited statistically significant difference ($p < 0.05$) in the regions of left ear, nose, maxillary sinus, left eye, thorax zone, sacrum, coccyx, pelvis minor zone, blind gut, appendix, immune system, right kidney, thyroid gland, hypothalamus, epiphysis, mammary glands and respiratory system and heart (images without filter) and throat, larynx, trachea, thyroid gland, mammary glands and respiratory system and heart (images with filter).

Mothers of autistic children *versus* control group (Table 3) demonstrated statistically significant difference ($p < 0.05$) in acupuncture regions corresponding to right eye, right ear, nose, maxillary sinus, throat, larynx, trachea, thyroid gland, left eye and epiphysis (images without filter) and right eye, jaw and teeth left side, left ear, nose, maxillary sinus, left eye, cervical zone, thorax zone, abdominal zone, pancreas and right part of heart (images with filter).

4. Discussion

The GDV biometric technique has been successfully used in psychology and cognitive studies mainly to assess the psycho-emotional and physiological state of an individual as well as to evaluate the changes that take place in a human organism over a period of time. Based on integral parameters such as form and size of electro-photonic emission, symmetry and relationship of the captured image with the rest of the GDV-grams of all fingertips, the presence or absence of aggressive signs and defects with the organs/organ systems one can conclude about the functional state of an individual at the moment of study [7,8].

Autism is a severe neurodevelopmental disorder with the development prior to 3 years of age [9]. The cause of autism remains unknown, and it is a heterogeneous disorder as to its etiology and phenotype. Autistic children are vulnerable to oxidative stress and are easily influenced by genetic, environmental, and immunological factors [10]. Immune [10-13], autoimmune, and infectious factors [14,15] have also been mentioned as playing role in the manifestation of autism. GDV assessment of psycho- emotional and physiological state of autistic individuals confirms that acupuncture regions on fingertips corresponding to the regions of "spleen" and "immune system" significantly differ from the same regions in controls (Table 1). The genetic nature of autism is

unclear; there is no single gene that has been found to be associated with autism. Instead, multiple genes have been reported as being associated with autism [16]. Patients with autism can differ in the severity and scope of their symptoms suggesting that multiple factors contribute to explaining the disorder's symptoms. Environmental aspects, such as mercury, lead, measles, rubella virus, retinoic acid, maternal thalidomide, valproic acid and alcohol use during pregnancy and stress have been implicated in autism [17,18]. In addition, patients with autism are described as having behavior impairments, gastrointestinal deviations [19] and epilepsy [20]. According to GDV testing, autistic children have shown significant difference from normal children in acupuncture regions corresponding to descending, transverse, ascending colon, blind gut, appendix, pelvis minor zone as well as nervous system which may relate to behavioral impairments in autistic individuals. Recent clinical evidence emphasizes the significance of oxidative stress in the development and expression of autism [21]. Interestingly, autistic children in our experimental setting have acupuncture regions corresponding to respiratory system, trachea, larynx, maxillary sinus significantly different from controls and many impaired manifestations in autism relate to weakness of respiratory muscle in autistic patients [22]. There are numerous studies in the medical literature [23-30] that confirm cerebral hypoperfusion (decreased blood flow to the brain) in as many as 86% of individuals with autism [23]. Furthermore, this diminished blood flow typically correlates with many core autistic symptoms. Thus, it has been suggested that abnormal areas in the cerebral cortex are related to the cognitive impairments (such as deficits in language, impaired executive function and abnormal responses to sensory stimuli) observed in autistic children. In fact, sometimes the cerebral blood flow actually decreases, and this appears to be mediated, in part, by inappropriate vasoconstriction (narrowing of blood vessels) instead of vasodilation [31]. Cerebral hypoperfusion appears to lead to cerebral hypoxia (impaired oxygen delivery) to the brain in some autistic individuals. The cause of cerebral hypoperfusion in autistic individuals is unknown, but might be due to inflammation. Inflammation around blood vessels can cause the vessel wall to become stiff and inflexible. Vasculitis decreases the ability of the blood vessel to dilate and can lead to diminished blood flow. Other studies confirm the presence of inflammation in the brain of some autistic individuals. Inflammation, generally associated with increased content of water (edema), can increase the space between cells [32], and might increase the amount of fluid present inside cells [33]. Furthermore, the ability of one brain cell to communicate to another cell is reduced in some autistic children when compared to neurotypical children [34]. Thus, there exists a high probability that inflammation present in the brain of some autistic individuals is leading to diminished blood flow, impaired functional connectivity, impaired cognition, and increased fluid inside brain cells. Researchers at the Pennsylvania School of Medicine have shown constricted blood vessels and low blood flow in autistic individuals via biochemical analysis [35]. Our results shown in Table 1 confirm that there is a significant difference between autistic children and normal children (images without filter) for acupuncture region corresponding to cerebral vessels and cerebral cortex which could imply that autistic children may have malfunctioning blood flow in cerebral vessels and cortex.

5. Conclusions

All compared groups have shown significant difference on both psycho-emotional (images without filter) and physiological (images with filter) levels. However, the differences between autistic children and controls expressed on psycho-emotional level were the most significant as compared to the other groups. Therefore, the activity of the sympathetic autonomic nervous system is significantly altered in children with autism. The biometric method based on GDV is a promising step in autism research that may lead towards creating a disease profile and identify unique signature/biomarker for autism. Further work should involve more participants in order to augment our findings.

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