RESEARCH REPORT
Draft
Investigations into Stress and it's Management using the Gas Discharge Visualisation Technique

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Introduction

The Gas Discharge Visualisation Technique (GDV) was developed by Konstantin Korotkov at St Petersburg State Technical University during the 1990s (see Korotkov 1998). In essence, a high intensity/tension/frequency electric field (3-20 kV, 1000Hz, for 10 microseconds) is created around an object which produces a gas discharge. As this discharge is accompanied by photon emission it can be photographed and analysed using appropriate computer software. In the basic technique there are therefore two outputs:

a) a photographic image
b) a set of parameters based upon the computer analysis of that image.

All objects, both animate and inanimate, when placed in a high tension electric field create a gas discharge the pattern of which is influenced by their properties. In the 1880's, Nicola Tesla a Czech physicist working the US found that luminous discharges appear around the body when it is exposed to high frequency electromagnetic field. Since the 1940's Kirlian photographs also produced by exposure to an electric field have revealed a human "aura". The existence of the phenomenon is not in question, however, it's explanation is.

One can discern three broad approaches to explanation, which are not mutually exclusive: the biological, the biophysical and the metaphysical.

The biological approach views the GDV image as a result of a temporary local reaction to an electric impulse, e.g. the ionisation of water molecules or salts on the skin, or a reaction to the iron in the blood. The gas discharge may also enable the photographic capture of the permanent but not normally visible thermal energy field around the fingers. Thermal imaging cameras reveal such a field quite clearly. Thus the change observed in an individuals image over time and the differences observed between individuals, are considered likely due to differences within and between people in the properties of their skin, body tissues and plasma. Such change can be linked to differences in finger metabolism which arise because of differences in organ functioning, diet, hormones, body rhythms, autonomic nervous system, or psycho-emotional states. Thus, the GDV image can be reasoned to have a biological basis which may reflect in a general manner both body functioning and mental states.

The biophysical approach uses our developing knowledge of body physics to provide an explanation. Thus, Korotkov argues that in addition to a thermal convection field that the human organism also has a complex electromagnetic field "which varies in response to the slightest changes in physiological condition". The GDV image is influenced by this field because "under the high frequencies that are generated by sharp pulses the nature of the discharge is influenced by the properties not only of the local area of the skin by the electrode, but of the whole body as well"(p45). Thus a key distinction of the biophysical from biological approach, is that the images are not just the product of a local reaction but reflect the whole of the body's energy field. "The physical aura of the biological object and man in particular is the total combination of the physical fields and radiations, formed by a body in space both due to its own emission and interaction with the processes in the environment"(p30).

The Western medical models of disease see threats to health and well-being as originating from outside the self. Illness is due to trauma, poisoning, or infection from some external toxic source. However, our capacity for homeostasis and immunological competence is affected not only by physical factors, but also by our level of emotional and mental well-being. From Eastern perspective our illnesses are often a reflection of our internal states of emotional unrest, spiritual blockage, and dis-ease.
Holistic Eastern models see the mind and body as part of the interconnected system. Thus, stress management techniques such as acupuncture, meditation, yoga, and tai-chi are reasoned to balance the human energy field by unblocking energy meridians. All of these techniques aim to achieve the integration of body, mind and soul. There is an assumption in the spiritual approach that a strong and complete body energy field represents a desirable healthy and harmonious state.

Korotkov uses the Su Jok system of acupuncture developed by Park (1993) to construct the body aura from parameter analysis of the finger images. "..the whole body of a person can be seen as projected onto one finger... consider the body as being organised on fractal principles... these ideas suggest that the energy system of the body displays holographic properties.. it is becoming recognised, that at some deep level, not only the body, but the whole universe has a fundamentally holographic structure. If this is true, ... it means that the finger images can be a sufficient indication of the energy condition of the whole body"(p75). This reconstruction from the sectors of the image, represents the third output from the GDV, and is clearly dependent upon the validity of the Su Jok system.

Characteristics of the GDV Images and Parameters

Research questions:

a) For the same individual, are there significant differences in the images of different fingers at one point in time?
b) At one point in time, do different individuals display significantly different finger images? Can one individual be distinguished from another on the basis of their finger-prints? And if so,
c) Can GDV images be categorised in a reliable way? So that a number of judges acting independently would categorise the images similarly? What is the level of inter-judge agreement? To what extent do these categorisations differentiate between individuals?
d) To what extent does the categorisation of images remain stable over time? If the type of image changes, by the minute, hour, day or month can these changes be attributed to known effects? Or is the change apparently random?

The answers to these questions will indicate whether or not GDV images are *potentially* useful measures.

e) For the same individual, are there significant differences in the image parameters of different fingers at one point in time?
f) At one point in time, do different individuals display significantly different finger parameters? Can one individual be distinguished from another on the basis of their finger parameters?
g) To what extent do the parameters remain stable over time? If the parameter changes, by the minute, hour, day or month can these changes be attributed to known effects? Or is the change apparently random?

The answers to these questions will indicate whether or not GDV parameters are *potentially* useful measures.

Characteristics of the GDV Finger Images

Whilst the sample used is small, 11 people tested on two occasions giving 220 finger images, four types of image can be distinguished. There are clear differences between individuals in the nature of their finger images. These images appear to relate to
Korotov's S, L, K+R, and N types. However, it is unnecessary to assume a Kirlian connection and for the present we will use a simple alphabet for classification: A, B, C & D types. The A, B & C types appear to reflect a continuum ranging from very fragmented weak images to complete rings. D images appear to be a qualitatively different type showing very distinctive lightning.

Figure 1: Types of GDV Finger Image

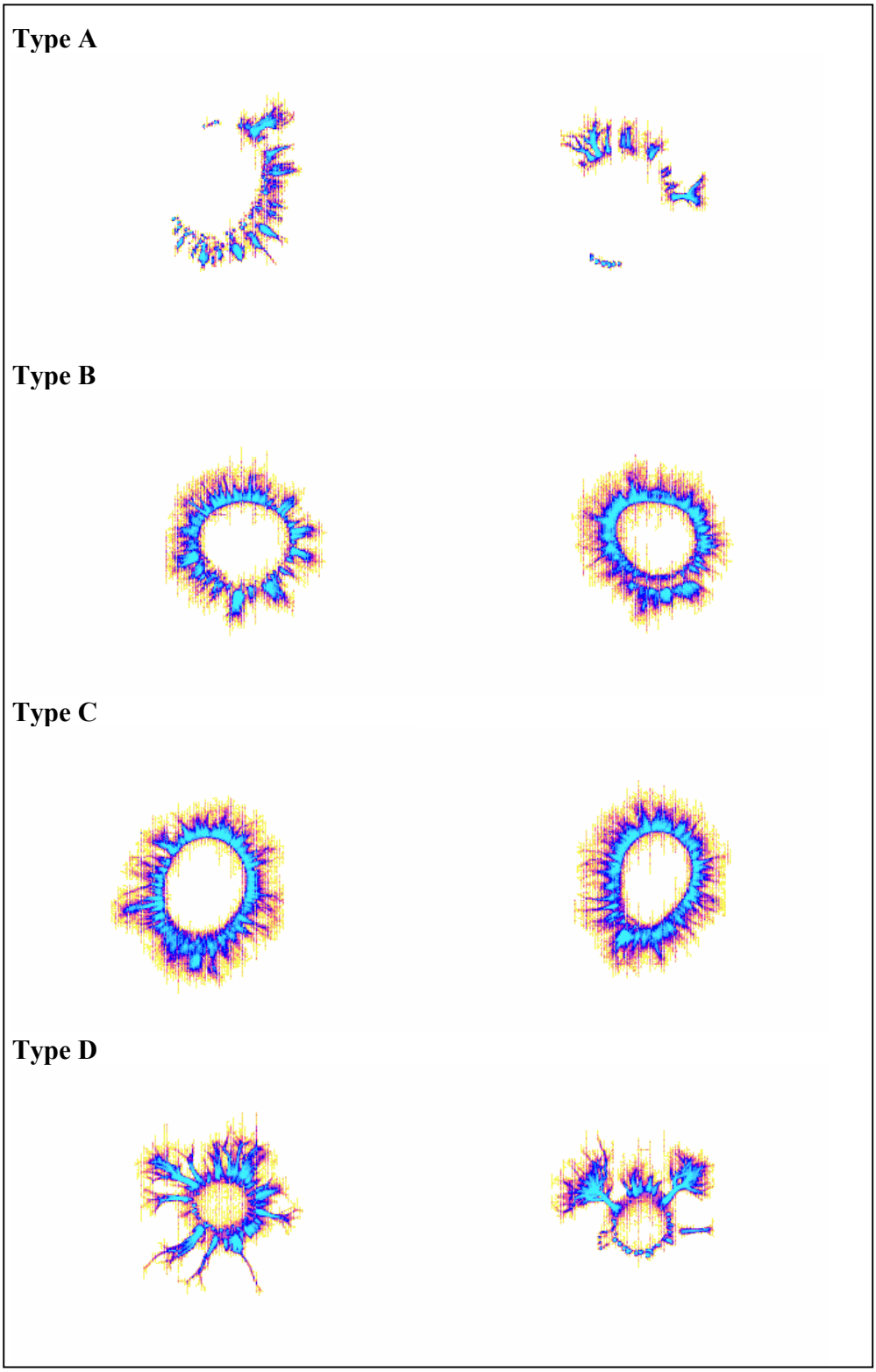


Table 1 : Finger type of different subjects (before & after workshop)

Subject No.	A	B	C	D		A'	B'	C'	D'
1				10			7	3	
2 (2 deleted images)	3	4	1				4	5	
3		9	1					10	
4		4	6				3	7	
5	10						6	4	
6	10					10			
7		8	2				7	3	
8	10					9	1		
9	6	4				10			
10		10					8	2	
11	8	2				9	1		

There is a noticeable similarity in the finger images for any one person at any one time - they are largely of the same type. Indeed in many cases it is not unreasonable to refer to a Type A, B, C or D person. 39% of the images were categorised as A, 36% of the images were categorised as B, 20% of the images were categorised as C, and 5% as D.

Characteristics of the GDV Parameters

Reliability of Parameters.

The validity and hence usefulness of any measuring device is limited by its reliability. Reliability refers to proportion of variance in measurements, which are non-random. The traditional way of estimating the reliability of an instrument is to measure the same thing twice. If one measures the same thing, then a reliable instrument will provide the same measurement. Stability should not be confused with reliability. Temperature thermometers vary as temperature does, but at the same temperature a reliable thermometer will provide the same reading. GDV images present a problem similar to that of the thermometer. We know that they vary over time especially in their details (but far less so in the overall pattern or type). We need to estimate to what extent the variation is due to systematic effects, and what is due to randomness. The variability in GDV parameters can be represented thus:

Total variance = Attributable Variance + Residual

Thus the variance observed in the image parameters over repeated measurements will comprise variance due to some identifiable cause e.g., time of the day, hormonal levels, and variance which has no known cause - residual or "error" variance. Our first task is to estimate the proportion of "error" in the observations. Based on the work of Cronbach et al (1972) and Winer (1971) the reliability of the image parameters can be estimated thus:

Reliability = Attributable Variance/Total Variance or 1 - (Residual/Total Variance)

If residual variance can be considered to be due to random effects, such reliability estimates indicate the limits to the attainable validity and usefulness of the parameters - over a series of measurements (technically an infinite series) the correlation between a random effect and any other is zero.

The ANOVAs given in Tables 8, 12, 16 & 20 provide an estimate of the reliability of the four image parameters used in this research. The attributable variance is that due to differences between subjects, fingers, hands, when they were tested, and their two-way interactions. After Hays (1981), the variance due to these effects is given by the Sum of Squares. Hence reliability is given by SSexplained/SSTotal.

83% of the variance observable in the parameter image area can be attributed to known systematic effects, which represents a reliability coefficient of 0.91.

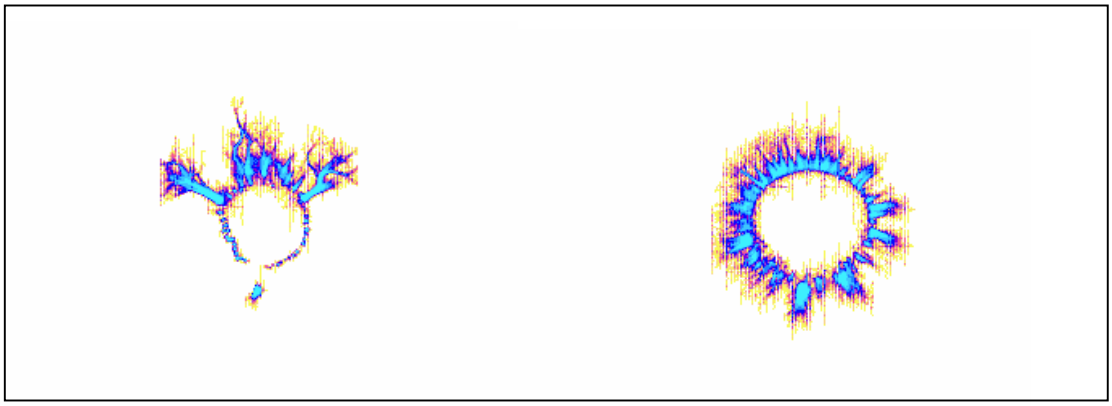
80% of the variance in the brightness parameter can be attributed to known systematic effects, which represents a reliability coefficient of 0.895.

60% of the variance in the fractal coefficient can be attributed to known systematic effects, leaving 40% unattributed. This represents a reliability coefficient of 0.77.

54% of the variance in the form coefficient can be attributed to known systematic effects, leaving 46% unattributed. This represents a reliability coefficient of 0.73.

From this analysis we can conclude that the GDV parameters, area and brightness are quite reliable, but fractal and form are really rather unreliable. This means that an individuals "true" score on these measures may be significantly different to that observed. Both of these parameters refer to the shape or pattern of the GDV image. Inspection of the individual images supports the view that these parameters do not reflect the shape of the images. Images, which are visibly very different, can have the same fractal and form measurements. For example, the two images below both have the same fractal coefficient (2.12) and very similar form coefficients (56.4 & 55).

Figure 2: Two GDV images with the same Fractal and Form Coefficients



Korotkov (1998) does signal potential problems with these parameters when the images are fragmented. And many of our stressed subjects do have fragmented images. This analysis raises

doubts over the usefulness of these parameters and any sector analysis and aura re-construction based upon them.

Distribution Characteristics

Table 2 provides the scale distribution characteristics of the four parameters. Brightness and the Fractal coefficient have rather small standard deviations.

Table 2: Distribution characteristics of GDV parameters

Variable	Mean	Std Dev	Minimum	Maximum	N
FRACTAL	2.28	.16	1.847	2.682	197
FORM	72.65	17.46	30.464	144.314	197
BRIGHT	222.00	3.58	208.840	229.440	197
DARK	6501.44	1984.56	1103.000	9969.000	197

Variation of GDV parameters between people, fingers and hands

a) Area of GDV image

Table 3 reveals that there are significant differences in the image area overall between subjects, between fingers, that different subjects reveal different pattern for their left and right hands, and that the area of the image associated with a particular finger is influenced by being on the left or right hand. Table 3 gives the means for these significant effects.

Table 3: Sample Means for area of GDV image

Between Subjects

1	2	3	4	5	6	7	8	9	10
6755.20	7329.47	6926.10	7844.00	6798.10	3585.20	8204.85	5325.60	7494.05	4876.05
(20)	(17)	(20)	(20)	(20)	(20)	(20)	(20)	(20)	(20)

Between Fingers

1	2	3	4	5
5800.53	6575.55	6239.21	6455.88	7433.20
(40)	(38)	(39)	(40)	(40)

Hand by Subject

Subject	1	2	3	4	5	6	7	8	9	10
Right	7188.70	6908.00	7014.30	7151.80	6513.60	4366.20	8066.20	4890.90	7497.20	4644.40
	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
Left	6321.70	7931.57	6837.90	8536.20	7082.60	2804.20	8343.50	5760.30	7490.90	5107.70
	(10)	(7)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)

Hand by Finger

Finger	1	2	3	4	5
Right	5309.50	6366.90	6309.35	6422.70	7712.20
	(20)	(20)	(20)	(20)	(20)
Left	6291.55	6807.39	6165.37	6489.05	7154.20
	(20)	(20)	(20)	(20)	(20)

b) Brightness of GDV image

Table 4 reveals that there are significant differences in the brightness of the finger images overall between the subjects, and that the brightness of a particular finger varies between subjects. The

table below gives the means for these significant effects. It should be noted that Subject 1 is identifiably different to the others and that less significant effects would be found with this subject excluded.

Table 4: Sample Means for brightness of GDV image

Subject	1	2	3	4	5	6	7	8	9	10
	216.58	223.75	221.90	224.34	222.14	221.77	223.61	220.18	222.59	223.45
	(20)	(17)	(20)	(20)	(20)	(20)	(20)	(20)	(20)	(20)

Finger	1	2	3	4	5
Subject 1	215.21	217.86	216.77	216.99	216.05
	(4)	(4)	(4)	(4)	(4)
2	223.50	224.11	224.23	224.04	223.18
	(4)	(2)	(3)	(4)	(4)
3	222.22	221.30	222.36	222.92	220.70
	(4)	(4)	(4)	(4)	(4)
4	228.08	225.10	222.93	223.44	222.16
	(4)	(4)	(4)	(4)	(4)
5	224.25	222.81	220.86	221.13	221.65
	(4)	(4)	(4)	(4)	(4)
6	220.41	221.78	223.99	219.66	223.03
	(4)	(4)	(4)	(4)	(4)
7	226.04	222.94	224.10	224.07	220.91
	(4)	(4)	(4)	(4)	(4)
8	219.37	219.30	220.41	220.37	221.44
	(4)	(4)	(4)	(4)	(4)
9	223.67	221.08	222.27	223.38	222.54
	(4)	(4)	(4)	(4)	(4)
10	226.43	224.34	220.48	221.08	224.91
	(4)	(4)	(4)	(4)	(4)

c) Fractal Coefficient of GDV image

Table 5 reveals that there are significant differences between subjects in the overall fractal of their finger images, that overall different fingers have a different fractal coefficient, and so too do the different hands. The difference in the fractal of a particular finger varies across different subjects.

Table 5: Sample Means for the Fractal coefficient of the GDV image

Subject

1	2	3	4	5	6	7	8	9	10
2.23	2.32	2.37	2.31	2.26	2.26	2.30	2.17	2.30	2.28
(20)	(17)	(20)	(20)	(20)	(20)	(20)	(20)	(20)	(20)

Finger

1	2	3	4	5
2.26	2.28	2.34	2.25	2.27
(40)	(38)	(39)	(40)	(40)

Hand

1	2.30
	(100)
2	2.26
	(97)

Finger	1	2	3	4	5
Subject					
1	2.24	2.28	2.20	2.23	2.18
	(4)	(4)	(4)	(4)	(4)
2	2.41	2.23	2.34	2.32	2.26
	(4)	(2)	(3)	(4)	(4)
3	2.28	2.40	2.44	2.32	2.40
	(4)	(4)	(4)	(4)	(4)
4	2.21	2.27	2.45	2.31	2.32
	(4)	(4)	(4)	(4)	(4)
5	2.24	2.24	2.28	2.33	2.22
	(4)	(4)	(4)	(4)	(4)
6	2.13	2.30	2.44	2.27	2.17
	(4)	(4)	(4)	(4)	(4)
7	2.28	2.28	2.38	2.26	2.31
	(4)	(4)	(4)	(4)	(4)
8	2.18	2.13	2.28	1.97	2.29
	(4)	(4)	(4)	(4)	(4)
9	2.34	2.49	2.21	2.23	2.22
	(4)	(4)	(4)	(4)	(4)
10	2.28	2.18	2.36	2.26	2.32
	(4)	(4)	(4)	(4)	(4)

d) Form Coefficient of GDV image

Table 20 reveals that overall there is a significant difference in the form coefficient between different subjects. The Table below provides the relevant means.

Table 6: Sample Means for the Form coefficient of the GDV image

Subject	1	2	3	4	5	6	7	8	9	10
	70.15	71.86	60.96	71.77	72.43	72.24	74.46	73.93	70.28	88.35
	(20)	(17)	(20)	(20)	(20)	(20)	(20)	(20)	(20)	(20)

Let us return to our research questions.

a) For the same individual, are there significant differences in the images of different fingers at one point in time?

There is some discernible variability in the finger types for a particular individual and might be the case that there are individual differences in variability, but in general the same individual appears to have finger images of the same type. So much so that most of our samples could be classed as Type A, B, C or D people.

b) At one point in time, do different individuals display significantly different finger images? Can one individual be distinguished from another on the basis of their finger-prints?

Different individuals do display different images but beyond broad categorisation of type one could not with any certainty conclude that a particular image belonged to a particular individual. For example, having categorised a particular image as Type A, one could not determine which Type A individual the image belonged to. In one or two cases there did appear to be an image

peculiarity with a particular finger that re-occurred. One would not rule out the possibility that some individuals might display fairly stable characteristics in their images, which could form the basis of a more specific diagnosis.

c) Can GDV images be categorised in a reliable way? So that a number of judges acting independently would categorise the images similarly? What is the level of inter-judge agreement? To what extent do these categorisations differentiate between individuals?

To be undertaken

d) To what extent does the categorisation of images remain stable over time? If the type of image changes, by the minute, hour, day or month can these changes be attributed to known effects? Or is the change apparently random?

Over the 2.5 hour period there was in most images a significant change, but this change was for the most part in a similar direction (towards a more complete and stronger image) and is at this time attributed to the impact of the stress management workshop. A control group is needed here.

e) For the same individual, are there significant differences in the image parameters of different fingers at one point in time?

Image area and the fractal coefficient revealed highly significant differences between fingers. Brightness revealed only just differences, and there was no significant difference between the form coefficient of different fingers.

f) At one point in time, do different individuals display significantly different finger parameters? Can one individual be distinguished from another on the basis of their finger parameters?

All the parameters revealed highly significant differences between subjects. And for the parameter brightness alone there is a highly significant subject finger interaction, i.e., different subjects vary in the brightness of a particular finger. However, this does not enable one to distinguish between individuals on the basis of their parameters. The problem is rather like that of the thermometer. A most useful instrument but one couldn't identify a particular individual knowing that someone had a temperature of 101F, anyone could have such a temperature.

g) To what extent do the parameters remain stable over time? If the parameter changes, by the minute, hour, day or month can these changes be attributed to known effects? Or is the change apparently random?

There was significant variability over time in all the parameters except brightness. In this case different individuals changed to differing degrees. However, area and brightness were found to be reliable parameters. Whereas form and fractal reveal a significant amount of unexplained variance.

With the exception of the form and fractal coefficients, the GDV parameters and the image types are *potentially* useful measures. They discriminate between individuals and appear to do so in a meaningful and reliable way. Having considered issues of discrimination and reliability our

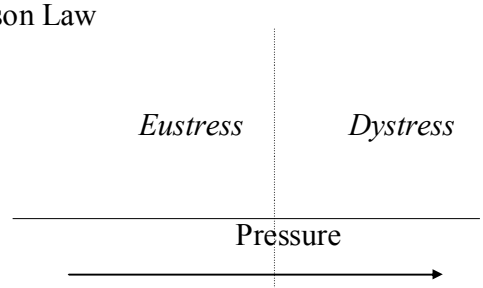
attention now needs to turn to the question of validity and utility. What do the images and parameters represent and are they of any practical use?

Impact of a Stress Management Workshop upon GDV images and parameters

Introduction

Stress is a complex concept. It can be seen as both a stimulus and as a response. Thus we talk about the stresses and strains of modern life, i.e., the pressures of life; and we also refer to feeling stressed or under stress i.e., a reaction to these pressures or stressors. When viewed as a stimulus it is reasonable to refer to positive and negative consequences of stress (eustress and dystress - Seyle) i.e., a certain amount of pressure in our lives is beneficial. However, excessive pressure results in decreased performance, irritability, coronary heart disease, stomach ulcers, and so on.

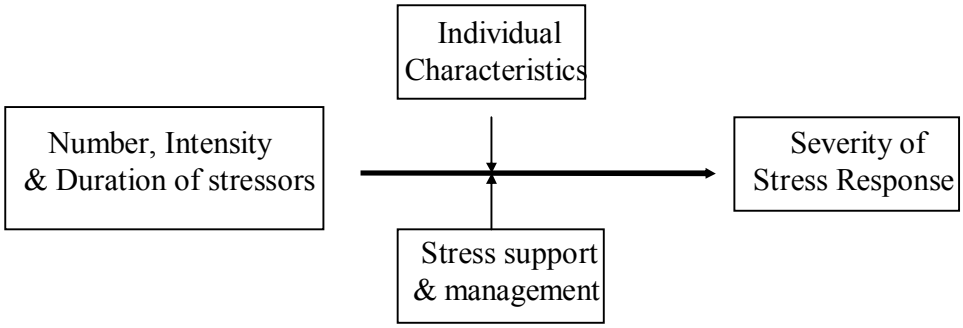
Figure :Yerkes-Dodson Law



Stress can be charactersised as a physiological or psychological state. The body can be considered under pressure from workload, noise or disease. However, stress for us, is a psychological phenomenon. It may have its basis in our physical environment or role, or in disease but these factors do not necessarily result in psychological stress. Stress is the result of excessive demands placed upon the person. Pressure can have positive effects, but stress is bad for you. These demands have cognitive, emotional, physiological and behavioural consequences. Dependent upon the intensity and duration of pressure and upon the individual characteristic the stress response varies in degree. Stress i.e. pressure can cause a debilitating stress reaction in one person, and represent a positive challenge for another. At one extreme it characterised by worry and anxiety, feelings that one can't cope, and perhaps irritability, at the other extreme it is characterised by mental abnormality and full-blown neurotic or psychotic symptoms. Thus to varying degrees, a stressed person is characterised by difficulties in concentration, short attention span, forgetfulness, indecisiveness, decreased reasoning and problem solving ability, emotionality, moodiness, hypersensitivity to criticism, anxiety, low self-esteem and feelings of inadequacy, loneliness, helplessness, depression, anger, aggression, neuroses; high blood pressure, increased blood sugar, dryness of the mouth, sweating, depression of the immune system, muscle tension, back pain, headaches, ulcers, stomach and intestinal problems, coronary heart disease, karoushi; sleeplessness, poor work performance, strained social relationships, autocratic management style, intolerance, absenteeism, rigidity, regression, avoidance, anorexia, impotence, compulsive behaviour, alcoholism, obesity, self-mutilation, suicide.

Stress is mediated by an individuals perceptions and is moderated by personality - one person's stressor is another's challenge. Melancholics (neurotic introverts) are stress prone, whereas

sanguine individuals (stable extraverts) represent the hardy personality. Eysenck (1967, 1985) has related these personality differences to individual differences in the balance of inhibition/excitation in the Reticular Activating System (RAS) and in the arousability of the autonomic system.

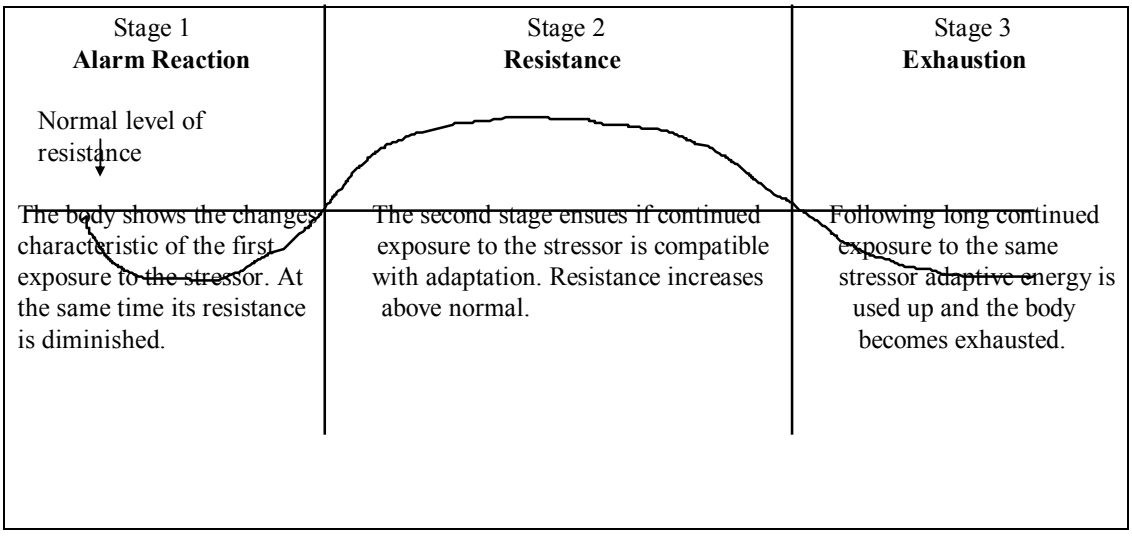


Anxiety, fear and stress need to be distinguished. Anxiety and fear are characteristic of stress but they are also frequently short-term reactions to a specific situation and consequently do not necessarily have the severe medical consequences of stress. In contrast, stress is additive and has a longer time frame - to the point of exhaustion or burnout.

The physiological correlates of anxiety or fear, the flight-fight reaction, are well documented. Essentially it involves a three-phase response to a stressor.

1. Reaction of the sympathetic system in response to cortical mediation and hypothalamic reactivity - increased heart rate, vasoconstriction of blood vessels in gut and skin, increased blood pressure, inhibition of peristalsis, sweating,
2. Reaction of the adrenal medulla in response to ACTH produced by the anterior pituitary gland, the release of adrenaline, conversion of glycogen into blood glucose, the reinforcement of the sympathetic effects and increased excitability of CNS through the RAS.
3. Reaction of the adrenal cortex in response to ACTH, but also perhaps AGTH from the pineal gland, the release of corticoids e.g. aldosterone which have a conservation effect and inhibit the production of ACTH. What is less clear are the physiological mechanisms operating over a longer time period, which result in exhaustion or burnout.

Figure 3: Seyle's (1976) General Adaptation Syndrome



There are good reasons to believe that stress will have a general impact upon the body metabolism that could be picked up by the GDV technique. From an empirical point of view Korotkov reports an association between the GDV images and parameters (primarily the area parameter) for people in stressful situations e.g., chess players and shooting competitors, and various physiological measures e.g., eozinophiles, GSR, pulse rate, arrhythmia. Chalko (in Korotkov 1998) reports an increase in the area and decrease in fractal parameters for individuals undergoing meditation and concentration exercises. Unfortunately these experiments utilise few subjects (frequently only a single individual), no control groups, and are reported with inadequate detail.

Research questions:

a) Is it possible on the basis of the GDV images or parameters to determine a priori whether or not an individual is under stress? How certain can we be?

b) Is change to the GDV images or parameters associated with self-reported reduction in stress? What is the nature of this change and is it consistent across people?

Method

The sample comprised 11 self-selected participants on a 2-hour stress management programme. Using standard procedures the participants had their "auras" measured before and after the workshop. They were also asked to complete a short questionnaire before the workshop asking for their current stress levels and again after the workshop asking whether or not they felt less stressed than before.

Initial inspection of the images and parameters revealed three images which appeared to be in error, and one GDV analysis which produced incomprehensible figures i.e. they did not relate to the images and were such extreme outliers that they would have skewed subsequent analysis (there would appear to be a bug in the GDV analysis programme). The three images and the data relating to one whole individual were removed from the analysis.

Results

The results before and after the workshop were compared for both change in the finger type, and in the four GDV parameters. Subjects reported moderate to high levels of stress before the workshop, and all stated they felt less stressed after it.

Change in Image Type.

All the finger images were categorised using the system already outlined, before and after the stress workshop and the changes noted. These are given in Table 7

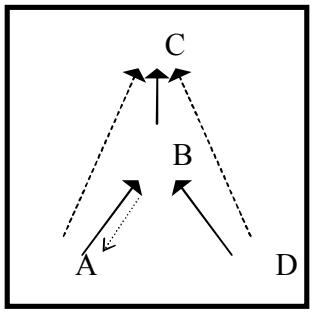
Table 7: Image Types Before & After the Workshop

		AFTER				
		A	**B**	**C**	**D**	**Total**
	A	32	9	6	0	47
BEFORE	**B**	6	20	15	0	41
	C	0	0	10	0	10
	D	0	7	3	0	10
	Total	38	36	34	0	108

In 7 of the 11 subjects there was a very visible change in the finger images, this applied to all or most of the fingers of both hands, and the change was towards type C i.e. an unbroken ring of uniform shape and was accompanied by an increase in the area of the images. In 2 of the subjects there was visible change in the opposite direction i.e. towards weaker images with greater dislocation, and in the remaining two subjects no visible change. All these last 4 subjects had finger images which were initially categorised primarily as Type A, i.e., they started with weak dislocated images and stayed the same or got worse.

Whilst it is true that there are visible differences between fingers, they are primarily of the same type, and the workshop had a similar effect on all fingers of both hands. This suggests a general effect, e.g. a broad metabolic change or in the overall level of bioenergy. The general pattern of change was towards C:

Figure 4: Schematic Change in GDV image types during workshop



Change in GDV parameters

Change in GDV parameters was investigated using ANOVA and the analyses investigating differences between subjects, fingers, and hands before and after the workshop are given in Tables 8, 12, 16, & 20 .

a) Change in the Area of the GDV image

Table 8: ANOVA of the Area of the GDV image

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	453955498	15	30263699.859	26.626	.000
SUBJECT	381010101	9	42334455.665	37.245	.000
FINGER	57645841	4	14411460.342	12.679	.000

HAND	1589817	1	1589817.331	1.399	.239
BEFORE/AFTER	13767266	1	13767265.575	12.112	.001
2-Way Interactions	183354453	63	2910388.146	2.561	.000
SUBJECT FINGER	38231658	36	1061990.499	.934	.580
SUBJECT HAND	33956425	9	3772936.133	3.319	.001
SUBJECT BEFORE/AFTER	91400416	9	10155601.791	8.935	.000
FINGER HAND	14116753	4	3529188.309	3.105	.018
FINGER BEFORE/AFTER	4351606	4	1087901.534	.957	.434
HAND BEFORE/AFTER	66391	1	66390.639	.058	.809
Explained	637816207	78	8177130.862	7.194	.000
Residual	134122703	118	1136633.079		
Total	771938911	196	3938463.829		

Table 8 reveals that there are highly significant differences in the area of the finger images before and after the workshop. It also reveals that there is a significant interaction between people and change i.e. not everyone showed a change in the area of the image before and after the workshop. Also there was no interaction between finger and change i.e. change affected all fingers similarly. These last two findings are compatible with the analysis of the finger images. The relevant means are given below. Overall the area of the image increased over the course of the workshop and this affected all fingers similarly. However, there were notable exceptions amongst the subjects, namely subjects 6 and 8, where the area decreased over the workshop.

Table 9: Significant differences in image area before and after stress workshop

i. Across all subjects, hands and fingers

Before	6240.51	
	(98)	
After	6759.74	
	(99)	

ii. Between subjects before and after workshop

Subject	1	2	3	4	5	6	7	8	9	10
Before	5869.60	6381.38	6585.60	7750.40	5480.90	3997.80	7955.20	6563.80	7233.40	4615.20
	(10)	(8)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
After	7640.80	8172.22	7266.60	7937.60	8115.30	3172.60	8454.50	4087.40	7754.70	5136.90
	(10)	(9)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)

Table 10: ANOVA of differences in image area before and after workshop

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	192495604	13	14807354.118	6.404	.000
SUBJECT	183258793	9	20362088.136	8.806	.000
FINGER	9236810	4	2309202.577	.999	.418
2-Way Interactions	91549506	36	2543041.822	1.100	.375
SUBJECT FINGER	91549506	36	2543041.822	1.100	.375
Explained	284045109	49	5796838.962	2.507	.001
Residual	110990748	48	2312307.240		
Total	395035857	97	4072534.604		

Table 11: Subject variation in difference scores

1	2	3	4	5	6	7	8	9	10
1771.20	1826.75	681.00	187.20	2634.40	-825.20	499.30	-2476.40	521.30	521.70
(10)	(8)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)

b) Change in the brightness of the GDV image

Table 12: ANOVA of the brightness of the GDV image

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	968.085	15	64.539	15.267	.000
SUBJECT	920.109	9	102.234	24.183	.000
FINGER	43.155	4	10.789	2.552	.043
HAND	5.993	1	5.993	1.418	.236
BEFORE/AFTER	1.141	1	1.141	.270	.604
2-Way Interactions	1048.906	63	16.649	3.938	.000
SUBJECT FINGER	351.224	36	9.756	2.308	.000
SUBJECT HAND	16.094	9	1.788	.423	.921
SUBJECT BEFORE/AFTER	609.067	9	67.674	16.008	.000
FINGER HAND	40.150	4	10.038	2.374	.056
FINGER BEFORE/AFTER	31.923	4	7.981	1.888	.117
HAND BEFORE/AFTER	.205	1	.205	.048	.826
Explained	2016.780	78	25.856	6.116	.000
Residual	498.841	118	4.227		
Total	2515.622	196	12.835		

Table 12 reveals that whilst there is no significant difference overall before and after the workshop, different people reveal significantly different change to the brightness of their finger images. In fact, most show little change or slight reduction in brightness, the significant difference is largely due to one subject, namely Subject 1.

Table 13: Significant differences in the brightness of the image before and after workshop

i. Between subjects across all fingers and hands

Subject	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Before	211.86	223.59	222.64	224.73	221.84	222.39	223.86	222.58	223.08	224.47
	(10)	(8)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
After	221.29	223.90	221.16	223.95	222.44	221.15	223.37	217.78	222.10	222.42
	(10)	(9)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)

Table 14 reveals that in terms of change to brightness scores there were highly significant differences between individuals, i.e., for some individuals their images increased in brightness, others decreased resulting in over all subjects no significant change (see above). There was no difference between fingers.

Table 14: ANOVA of brightness difference scores

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	1280.449	13	98.496	12.311	.000
SUBJECT	1217.387	9	135.265	16.907	.000
FINGER	63.062	4	15.766	1.971	.114
2-Way Interactions	349.916	36	9.720	1.215	.262
SUBJECT FINGER	349.916	36	9.720	1.215	.262

Explained	1630.366	49	33.273	4.159	.000
Residual	384.026	48	8.001		
Total	2014.391	97	20.767		

Table 15: Variation between subjects in image brightness before and after workshop

Subject 1	2	3	4	5	6	7	8	9	10
9.43	.14	-1.47	-.78	.60	-1.24	-.49	-4.80	-.98	-2.05
(10)	(8)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)

c) Change in the Fractal coefficient of the GDV image

Table 16 reveals that there were highly significant differences before and after the workshop in the fractal coefficient of the images. The fractal coefficient increases over the course of the workshop. There are significant differences between the subjects in the extent of this increase, and it effects the thumb more significantly than other fingers. The removal of Subject 1 from the analysis greatly reduces the significance of this finding.

Table 16: ANOVA of the Fractal Coefficient of the GDV image

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	1.120	15	.075	4.457	.000
SUBJECT	.518	9	.058	3.432	.001
FINGER	.179	4	.045	2.666	.036
HAND	.097	1	.097	5.775	.018
BEFORE/AFTER	.308	1	.308	18.389	.000
2-Way Interactions	1.824	63	.029	1.727	.005
SUBJECT FINGER	.978	36	.027	1.620	.028
SUBJECT HAND	.197	9	.022	1.305	.241
SUBJECT BEFORE/AFTER	.311	9	.035	2.064	.038
FINGER HAND	.095	4	.024	1.415	.233
FINGER BEFORE/AFTER	.200	4	.050	2.986	.022
HAND BEFORE/AFTER	.019	1	.019	1.139	.288
Explained	2.951	78	.038	2.257	.000
Residual	1.978	118	.017		
Total	4.928	196	.025		

The ANOVA of the difference measures, given in Table 18, also reveals that the variance in the change in the fractal coefficient over the course of the workshop cannot be explained by differences between subjects or finger. Other unknown factors are operating.

Table 17: Significant differences in the fractal coefficient of the finger images before and after workshop

i. Across all subject, hands and fingers

Before	2.24	
	(98)	
After	2.32	
	(99)	

ii. Between subjects across all fingers

Subject	1	2	3	4	5	6	7	8	9	10
Before	2.13	2.27	2.26	2.29	2.25	2.19	2.27	2.17	2.28	2.29
	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
After	2.32	2.37	2.48	2.34	2.27	2.34	2.34	2.17	2.31	2.26
	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)

iii. Between fingers across all subjects

Subject	1	2	3	4	5
Before	2.17	2.26	2.27	2.25	2.25
	(20)	(19)	(19)	(20)	(20)
After	2.34	2.31	2.40	2.25	2.29
	(20)	(19)	(20)	(20)	(20)

Table 18: ANOVA of difference measures of Fractal

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	1.012	13	.078	2.199	.024
SUBJECT	.621	9	.069	1.948	.067
FINGER	.391	4	.098	2.762	.038
2-Way Interactions	.596	36	.017	.467	.990
SUBJECT FINGER	.596	36	.017	.467	.990
Explained	1.608	49	.033	.927	.604
Residual	1.700	48	.035		
Total	3.308	97	.034		

Table 19: Variation in finger fractal coefficients before and after the workshop

Finger	1	2	3	4	5
	.17	.05	.13	.00	.03
	(20)	(19)	(19)	(20)	(20)

d) Change in the Form coefficient of the GDV image

Table 20 reveals that there are just significant differences in the form coefficient before and after the workshop. Table 22 reveals that the variance in difference measures before and after the workshop cannot be explained by variance due to different subjects or fingers. Once again there are other unknown factors operating.

Table 20: ANOVA of the Form coefficient of the GDV image

Source of Variation	Sum of Squares	DF	Mean Square	F	Si of F
Main Effects	9863.347	15	657.556	2.805	.001
SUBJECT	8033.570	9	892.619	3.807	.000
FINGER	490.321	4	122.580	.523	.719
HAND	9.599	1	9.599	.041	.840
BEFORE/AFTER	1306.897	1	1306.897	5.575	.020
2-Way Interactions	22148.309	63	351.560	1.500	.030
SUBJECT FINGER	9827.040	36	272.973	1.164	.268
SUBJECT HAND	5120.912	9	568.990	2.427	.014
SUBJECT BEFORE/AFTER	4423.010	9	491.446	2.096	.035
FINGER HAND	583.265	4	145.816	.622	.648
FINGER BEFORE/AFTER	1156.098	4	289.024	1.233	.301
HAND BEFORE/AFTER	1026.552	1	1026.552	4.379	.039
Explained	32062.086	78	411.052	1.753	.003
Residual	27663.862	118	234.440		
Total	59725.949	196	304.724		

Table 21: Significant differences in the form coefficient before and after workshop

i. Across all subject, hands and fingers

Before	75.34	
	(	98)
After	70.00	
	(	99)

Table 22: ANOVA of difference measures of Form

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	11019.897	13	847.684	1.579	.125
SUBJECT	8753.649	9	972.628	1.812	.090
FINGER	2266.248	4	566.562	1.055	.389
2-Way Interactions	15109.150	36	419.699	.782	.778
SUBJECT FINGER	15109.150	36	419.699	.782	.778
Explained	26129.047	49	533.246	.993	.510
Residual	25770.219	48	536.880		
Total	51899.267	97	535.044		

Conclusions

Let us return to our research questions. Our answers have to be tentative for until we have a control group, i.e., a group of subjects who report that they are not under stress, re-tested 2-3 hours apart, at the same time of day as our experimental group, no firm conclusion can be made.

a) Is it possible on the basis of the GDV images or parameters to determine a priori whether or not an individual is under stress? How certain can we be?

The tentative answer to this is that we probably cannot, with any certainty, tell whether or not an individual is under stress from their GDV image or parameters. Many of those reporting less stress after the workshop still displayed A & B images for the majority of their fingers, and a wide range of image areas (though relative to non-stressed others they may well still have been significantly stressed - after all, one would not expect the stresses and strains of life to be done away with completely during a 2-hour workshop). Further, it is likely that type A, B & C images have other causes than stress. Serious medical or emotional problems or their treatment are likely to have wide ranging metabolic - or bioenergetic - effects. However, we probably can conclude that an individual displaying type C images for the majority of his/her fingers is not under a significant level of physical or emotional stress.

The type D image appears to be qualitatively different to A, suggesting that there may be different types of stress reaction. One, highly speculative, explanation could be that D types represent an excitatory reaction, whilst As represent an inhibitory reaction similar to Seyle's exhaustion or burnout.

b) Is change to the GDV images or parameters associated with self-reported reduction in stress? What is the nature of this change and is it consistent across people?

Here the tentative answer is yes, there are significant changes in the type of image and the area of the image for the majority of people and that this effect applies to the majority of the fingers - it is a general effect and visibly dramatic in some cases. The change represents movement towards more complete and stronger rings, with a corresponding increase in the area of the image. However, there are subject differences. In a minority of cases the opposite effect was observed. In all the cases where there was no change or a weakening of the image, the subjects displayed primarily A type images. This raises the possibility of individual differences moderating the stress reaction.

Overall, reduced stress was also significantly associated with increased fractality and a decrease in image brightness. There does appear to be problems with the fractal parameter, and this finding is laid aside. The brightness parameter deserves further investigation.

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