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# A Comparison of the Aims and Objectives of the Human Brain Project with Grakov's Mathematical Model of the Autonomic Nervous System (Strannik Technology)

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## Abstract

This article makes a comparison between the Strannik technology which was developed during the period 1982-present by Dr Igor Gennadyevich Grakov and the EC Human Brain Project.

Sensory input influences the activity of the brain and the autonomic nervous system. In this article we report a technology which uses changes of colour perception within a mathematical model of the autonomic nervous system which has both diagnostic and therapeutic applicability. The fundamental methodology of this technique, and examples of how this technology can be used to diagnose the onset and progression of a wide range of medical conditions, and also to treat a wide range of medical conditions, have been described in an extensive programme of articles which have been published in various medical journals. Grakov's model has extensive applicability.

We make a comparison of this Strannik technology with the Aims and Objectives of the EC Human Brain Project (in particular sub-sections SP3 Cognitive Neuroscience, SP6 Neural Simulation, SP8 Medical Informatics) and illustrate that Grakov's Strannik technology has made extensive strides towards meeting these objectives including, but not limited to the following: (i) it is a neural simulation technique; (ii) it incorporates an understanding of the structural relationship between molecular biology, cell biology, organ function and the function of the organ networks; (iii) it is based upon an understanding of the relationship between genotype and phenotype; (iv) SVS can be invaluable to SP8 the Medical Informatics Platform because, as outlined, it effectively presents a new category of cognitively/biologically based diagnostics, supported by a strong mechanistic hypotheses of disease causation; and (v) because it involves an understanding of the mechanism which the brain uses to regulate the function of the autonomic nervous system and physiological systems.

Abbreviations: SVS: Strannik Virtual Scanning; SLT: Strannik Light Therapy; ANS: Autonomic Nervous System; HBP: EC Human Brain Project

## Introduction

Grakov's biomathematical model [1] is based upon the study of data input to the brain, behavioural output by the brain, and the flow of data between the visceral organs i.e. to and from the brain. In doing so Grakov avoided being influenced by prevailing opinion and contemporary biomedical research (although influenced by Russian researchers [2] who have studied this phenomena in research since the 1930's) and of trying to input data from experiential research and/or studies into an over-riding understanding of how the brain regulates the body's function. Western research is based upon a number of observations which are potentially misleading e.g.

(i) The brain regulates the body's function although this appears not to be widely accepted [3], therefore the question for the researcher is 'how and why does it do so?

(ii) that the study of molecular biology and pathophysiology can be accurately determined by measuring the levels of individual chemicals –

biomarkers – which can serve as determinants yet the body's function does not conform to reductionist principles i.e. it is rare for a medical condition to be precisely characterised by a single biological determinant . The problem for cognitive neuroscience researchers is to illustrate the mechanisms by which this occurs.

(iii) The contemporary understanding of colour perception is currently explained by non-chemical hypotheses yet changes of colour perception have been shown to be linked to the autonomic nervous system (ANS) and to have genetic and phenotypic correlates [4,5] i.e. colour perception has pathological correlates.

(iv) That scanning techniques are able to differentiate between the brain regions which handle psychological/emotional influences and pathological factors yet this ignores the influence of visceral pathologies and associated metabolites upon brain function, and that all aspects of brain function have biophysical origins.

(v) The contemporary explanation that proteins and other biologically significant molecules dissociate or migrate towards reactive substrates cannot be supported when considering the rapid, in some cases almost instantaneous way, in which the body functions. The challenge for researchers is to explain how the body can function so quickly.

(vi) That genetic changes are not necessarily indicators of a particular medical condition but instead may be the cause or the consequence of autonomic dysfunction thereby explaining why the genetic changes which accompany the onset of obesity can be largely if not completely reversed following the introduction of lifestyle changes including exercise and improved diet.

(vii) That the drug-based paradigm is the accepted treatment yet (a) drugs are based upon their interaction with the ANS, (b) drugs are only circa 50% effective [6], and (c) most people who live an active nutrient-rich lifestyle remain significantly more healthy throughout their lives.

Leading geneticist Eric Lander, who was credited for leading one of two teams which completed the task of decoding the genome, ably identified the dilemma for researchers when he compared the genome with a parts list for an aeroplane and of the need to find, identify or establish an operating manual in order to make it fly. This illustrates the dilemma for those researching the function of the brain e.g. in the Human Brain Project (HBP). The body's biochemistry is the human equivalent to the parts list. If so, where is the evidence of the mechanism which regulates its function?

Perhaps, more than any other researcher, Nobel Laureate Eric Kandel has understood this link between the conscious and unconscious mind, between sense perception and molecular biology, between genotype and phenotype, and between cognition and molecular biology; when he commented some years ago of the need for biologists to integrate sense perception into their research.

## Grakov's Mathematical Model of the Autonomic Nervous System

As outlined in MMHL/Ewing bibliography Grakov identified (i) that changes of colour perception have pathological correlates [4] which have a digital nature i.e. that genetic and phenotypic chemistries emit light which influences colour perception - the colour having qualitative significance and the intensity having quantitative significance; (ii) that the brain uses a frequency-related mechanism to stimulate and/or regulate the body's function [7]; and (iii) that psychology and physiology are two different manifestations of the body's function –akin to the head and tail of a coin.

This research programme commenced in the early 1980's when the young Dr. Grakov was requested to undertake and lead a programme of research to study the medical application of industrial lasers. He identified a biological response to a waveform which led to the first Strannik prototypes. After the initial work at the University of Novosibirsk the development was continued by Dr. Grakov in the company MIMEX OOO. By comparison the EC HBP involves hundreds of researchers from different locations across Europe and has funding of circa EUR1.2BN.

Grakov has not constructed a simplified brain model or laid foundations for an age-dependent model of the human brain (SP2) – he has just treated the brain as a black box with inputs and outputs - but he has included in his model compensatory adjustments for gender, age and weight. The structural basis of the mathematical model is that there is a dynamic relationship between two data matrices i.e. that of the neural and visceral matrices, and that the body is influenced by sensory input in addition to biological input.

The knowledge that there is a mathematical relationship between cognition and the brain's regulation of the ANS [4], is unsurprising when considering the fine tolerance limits under which the body operates (regulating the homeostasis of various physiological systems including temperature [8], acidity [9], blood pressure [10], blood glucose [11,12], sleep, etc), and is manifest in Strannik technology (comprising Strannik Virtual Scanning (SVS) & Strannik Light Therapy (SLT)) as a set of generic formulae and algorithms. This effectively dispenses with the need for the processing of Big Data by computers of immense scale and processing capacity. Such thinking is increasingly accepted by Systems Biologists who have recognised that there is a link between molecular biology, cellular biology, organ function, the coherent function of the organ networks (physiological systems), the ANS [13], and the function of neural networks [14,15].

Like all mathematical models Grakov's model is based upon a set of assumptions. It is based upon the observation that 85% of sensory input is visual and therefore that the visual route is the most sensitive and likely to be the most accurate and significant. The data generated to date appears to indicate that SVS is 2-23% more accurate than the range of contemporary diagnostic tests used in medical clinics in which the studies were carried out. Such statistics have been supported by in-market surveillance conducted by Mimex Montague Healthcare which has generated a considerable body of data which indicates that SVS performs at this general level of effectiveness.

Example 1: patient obtained a compensatory settlement as a result of misdiagnosis of a duodenal ulcer and the wrongful prescribing of aspirin. SVS identified the existence of a Duodenal Ulcer.

Example 2: SVS identified a patient with presymptomatic onset of pancreatic cancer. The medical services identified the condition 1-2 years later by which time it was inoperable. The lady undertook chemotherapy but died shortly thereafter. The SVS test was correct.

These are not isolated examples. Many more examples are available upon request and/or have been published in the attached bibliography/references. The technology has been demonstrated - repeatedly and invariably successfully - to medical directors of leading hospitals, doctors in primary and secondary care, executives working for Venture Capital companies, patients, etc. Over 600 medical doctors have been trained to use this technology.

In addition, SVS is able to provide a psychological and physiological profile from the same cognitive test which indicates that psychological traits, or at least changes to psychological profiles, have pathological origins e.g. how changes of hormone levels influence behaviour in the menopausal female, or how changes of oxytocin levels influence behaviour, or how psychiatric conditions are treated by drugs.

The SVS test developed by Grakov [16] incorporates a well-defined cognitive task(s), already partially studied by cognitive neuroscience (i.e. including measurements of perception, imagination/motivation, memory and associative thinking, and decision-making). It is able to define the health of the patient in a level of detail and sophistication which is unprecedented in modern medicine e.g.

(i) To diagnose the onset of pathologies from their earliest presymptomatic onset – because the eye is immensely sensitive to changes of colour perception;

(ii) To determine 5-15 common pathologies and diagnostic indications in each of 30 organs i.e. circa 400 diagnostic determinants in a single test – including many conditions for which there is currently considered to be 'an unmet clinical need';

(iii) To delineate between and/or measure the genetic and phenotypic components of every common pathology [17,18] e.g. regarding T1 and T2 diabetes; and

(iv) To do so non-invasively, in a test of circa 20-30 minutes duration, and at a level of cost which is estimated at typically 5-10 times lower than that of contemporary diagnostic tests.

Such a test, and related findings, has the potential to make considerable theoretic insight and contribution to many different areas of HBP research including the modelling of low-level biological processes. Moreover it addresses strategically selected themes which are considered to be essential to the goals of the HBP project e.g. mathematical techniques to produce simplified models of complex brain structures and, in particular, brain dynamics; rules linking learning and memory to synaptic plasticity; large-scale models creating a bridge between "high-level" behavioural and imaging data; and mathematical descriptions of neural computation at different levels of brain organisation.

It leads to potentially controversial conclusions e.g.

• That the brain regulates the genetic expression and subsequent reaction of proteins by a biofeedback mechanism [19]. That the brain must in some way regulate the genetic expression of proteins has been speculated upon by leading Systems Biologist Denis Noble, 2011. If so, it may be possible to stimulate this mechanism.

• To illustrate the contextual nature of the body's function [20,21] i.e. that different genetic profiles can be responsible for the expression of a particular protein; and that the understanding of the chemical structure of our DNA and genes must be complemented by an understanding of the structural nature of DNA and genes.

• To illustrate those genetic changes may arise as a consequence of changes to cell biology [21-23] and vice versa.

The Strannik technology, in particular the SVS test, is a neural simulation technique (SP6). It consists of a software programme which allows researchers to reconstruct and simulate detailed biological models of the brain – in the SVS report - displaying emergent structures and behaviours e.g. at the systemic level, organ level, cellular level and molecular level. Moreover such understanding aligns or links the basic psychological and physiological requirements for the basic elements of life – food, water, air, temperature/heat/shelter, sleep, procreation - with the fundamental purpose of the brain and hence of the associated physiological/functional systems – to regulate blood glucose, the elimination of body fluids, breathing, body temperature, sleep, sexual function, blood pressure, etc.

SLT is based upon an understanding of how the brain uses frequency to regulate the body's function [7]. Whereas most biofeedback and neuro feedback techniques are based upon a rudimentary understanding of the phenomena, which means that the results or outcomes are often inconsistent and viewed with suspicion, by contrast the knowledge gained from the SVS test enables the computation and selection of the precise frequencies for the patient and range of pathologies to be treated by SLT taking into account of previously unconsidered variables e.g. age, weight and gender.

Initial research has illustrated that SLT is typically 83-96% effective [24]. If so this poses additional awkward questions for contemporary biomedicine e.g. rather than complex behaviour of ion channels on the branches of neurons contributing to the shape of brain waves [25] - is it more likely that it is the brain waves which are influencing the behaviour of the ion channels? There is evidence that the influence of electromagnetic fields have a wide range of physiological effects e.g. influencing cell proliferation and cytokine production in human lymphocytes [26] and neutrophils [27], the flow of Calcium into pancreatic beta cells [28], sleep [29], blood pressure and heart function [30-32], brain function [33], etc.

It involves or supports the continuous integration of biological data and implementation of biological principles. It complies with the ultimate goal of the HBP project for a multi-scale (simple to complex), multi-level (genes to whole brain) model of how the human brain regulates the body's function.

SVS can be invaluable to SP8 the Medical Informatics Platform because, as outlined, it effectively presents a new category of cognitively/biologically based diagnostics, supported by a strong mechanistic hypotheses of disease causation. SLT presents a new strategy(s) for treatment which researchers have illustrated appears to be circa 83-96% effective.

SVS can be of value to SP11 the Neurorobotics Platform. It meets in its entirety the objective of the pilot project planned in the ramp-up phase to use the capabilities provided by the Brain Simulation, High Performance Computing and Neurorobotics Platforms to perform proof-of-concept simulation-based research into the multi-level brain mechanisms responsible for visual perception.

## Future Medicine: Strannik Technology

Strannik provides researchers in medicine and pharmacology with the tools they need to accelerate research into the causes, diagnosis and treatment of physiological, neurological and psychiatric disease. It meets the four long-term aims of the HBP project:

1. To identify differential disease signatures from clinical data made available through the Medical Informatics Platform (SP8) and, in particular, to develop new nosological classifications based on predisposing factors and biological dysfunctions rather than symptoms and syndromes.

2. To use biological signatures of disease as a source of insights into disease processes, testing specific hypotheses of disease simulation through modelling and simulation.

3. To use disease models to identify potential drug targets and other possible treatment strategies and to predict desirable and adverse effects.

4. To develop strategies for personalised medicine, allowing the development of treatments adapted to the specific condition of individual or specific subgroups of sensitive or vulnerable patients.

It includes, as part of the general report supplied for each patient, a model for the identification of biological signatures of physiological, neurological and psychiatric disease. Initial case studies have been recorded which conceivably demonstrate the validity of SVS as a test for Alzheimer's Disease and other medical conditions.

## The Strannik Model is

• Comprehensive, describing the main characteristics of each disease in its simplest elements e.g. identifying the most destabilised physiological system, whether a pathological functional system has been established, the most dysfunctional organs, cellular changes arising there from, and the precise medical nomenclature of the spectrum of developing pathology(s) e.g. complex multi-systemic , multi-pathological and polygenomic pathologies such as Diabetes [34], Migraine [35], Cardiovascular Disease [36], Raynaud's Phenomenon [37], Developmental Dyslexia [38,39];

• Complex, capturing non-linear interactions, confounding factors and hitherto undocumented differences e.g. illustrating the genetic factors which differentiate racial groups and/or geographical context

• Causal, making specific predictions about the mechanisms and predisposition to further disease states;

• Predictive i.e. able to identify the organs which will be affected if the patient continues with their current lifestyle, does not remove themselves from the stressful factors which affect their lives, and/or does not incorporate improvements to their lives e.g. through exercise and diet.

• Therapeutic i.e. enabling recovery of autonomic stability through the adaptation of knowledge of how the brain employs frequency to regulate the body's stability [7].

It has immense ethical and social significance ref SP12. It offers for each patient (and in past version of the technology 'combinations of patients and/or patient groups):

(i) A psychological profile which defines the influence of emergent pathologies upon the patient's psychological profile.

(ii) A viable drug-free treatment paradigm which can offer a viable alternative to the drug-based paradigm.

(iii) To identify (the reasons for) and to moderate extremes of behaviour by treating the pathologies which are responsible for erratic and/or extreme behaviour. This has particular value where the pathological correlates of stress create marital or work-based problems.

(iv) To identify the pathological correlates of conditions which are considered to have a psychological basis e.g. dyslexia/learning dysfunction [40], attention deficit disorder, and the disruptive consequences thereof to society.

It presents an opportunity to understand the fundamental issues which are of greatest concern to cognitive and developmental psychology and neuroscience i.e. (i) What do we do? (What is the function of the brain?), (ii) Why do we do it? (What is the fundamental rationale for its function i.e. what is it designed to achieve?), (iii) How do we do it? (How does the mass of neural components, neurons, axons and the body's biochemistry interact and function in order to achieve what it has been designed to achieve?).

## The European Dimension

The European market is a multi-speed market in which some countries have significant investments in the R&D and/or manufacturing of Medical Devices whilst other less wealthy countries have almost no indigenous medical device industries. Moreover all expenditure upon healthcare, irrespective of the location, represents a drain on a nation's finances and governance; especially so during periods of financial problems and rising social discontent.

In addition, the efficiency of the healthcare system is based upon the current level of knowledge which stems from reductionist research [41]. This leads to immense problems re (i) the diagnosis by the GP, (ii) the accuracy of medical tests, (iii) treatment by drugs, (iv) surgical removal of medical anomalies. Allopathic medicine is based upon diagnosing or treating the consequences of systemic dysfunction. There is a need for governments to stimulate growth by the adoption of technologies which focus upon the fundamental origins of autonomic dysfunction, and which can reduce expenditure on healthcare and use associated cost-savings to alter policies which are associated with 'financial deficits' to improve salaries, reduce taxes and improve after-tax incomes.

The scale of cost-saving which could arise from the introduction of Strannik technology is immense. The technology has interested the UK's Department of Health since 2010 when a report, compiled independently by ICON Development Solutions (a division of ICON plc), illustrated the potential of this technology to reduce the cost of diagnosing and treating diabetes from £9BN to £2.8BN.

The value of this technology is to enable the patient to have the means to test their health comprehensively and inexpensively, if necessary, in their primary care unit although not necessarily so. This would enable the patient to better manage their health and would have the effect of reducing the flow of patients to primary care, of patients from primary care to secondary care of repeat consultations in primary and secondary care, reducing the need

for surgical interventions, and reducing the flow of patients from secondary care to tertiary care. It would eliminate the need for tests, often extremely expensive tests, to be used in a screening capacity e.g. in cardiovascular and oncological medicine. It would greatly simplify and reduce the cost of diagnosing complex multi-systemic disorders. It represents a potential saving to the UK's National Health Service of an estimated £20BN pa. Nevertheless the political environment which currently exists in the UK (period 2010-2015) has obstructed and prevented any significant progress and/or evaluation of this technology.

To put this into context, it is possible to screen the health of the majority of people in the UK population (7-90 years) at least once per year for an estimated £2-4BN pa. At such level of cost, most countries in the EC would be able to upgrade the quality of the healthcare services provided. It would improve the access to healthcare in remote Greek Islands, in remote Northern Europe and in areas which have a low density of GPs.

In addition the provision of SLT would address the influence of stress upon the ANS (resulting in autonomic dysfunction) thereby improving the lives of patients' e.g.

Example 1: Patient 59 years experienced migraines since 11 years. Most severe Migraine suffered. Patient commenced SLT and has never had another re-occurrence of migraine.

Example 2: Patient circa 67 years lost the ability to speak five years previously (Dysarthria) [42] and was finally advised by his consultant they had tried everything to assist him without success. Patient commenced SLT and was able to speak normally in 6 days.

Example 3: Patient circa 80 years, prognosis of impending death from Mesothelioma and prostate cancer. Patient commenced SLT. After 4-6 months his oncologist was unable to explain how this man who had been expected to die within hours following an earlier consultation was now able to live and breathe freely without restriction. He passed away 1-2 years later.

Strannik technology has the potential to save the health services across Europe an estimated >£100BN pa. Such cost-savings would be invaluable to governments which have to introduce austerity measures in order to maintain their financial stability.

Finally, Strannik also has a wider social and green potentiale.g.to recognise the biological factors which influence our ability to learn, to recognise how stress influences our social cohesiveness, to treat drug-addiction, to monitor the effect of gaseous pollutants or other adverse influences upon patient health, etc.

G. Ewing

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## Conflict of Interest Statement

The authors have a vested interest in the future commercialisation of Strannik technology.

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