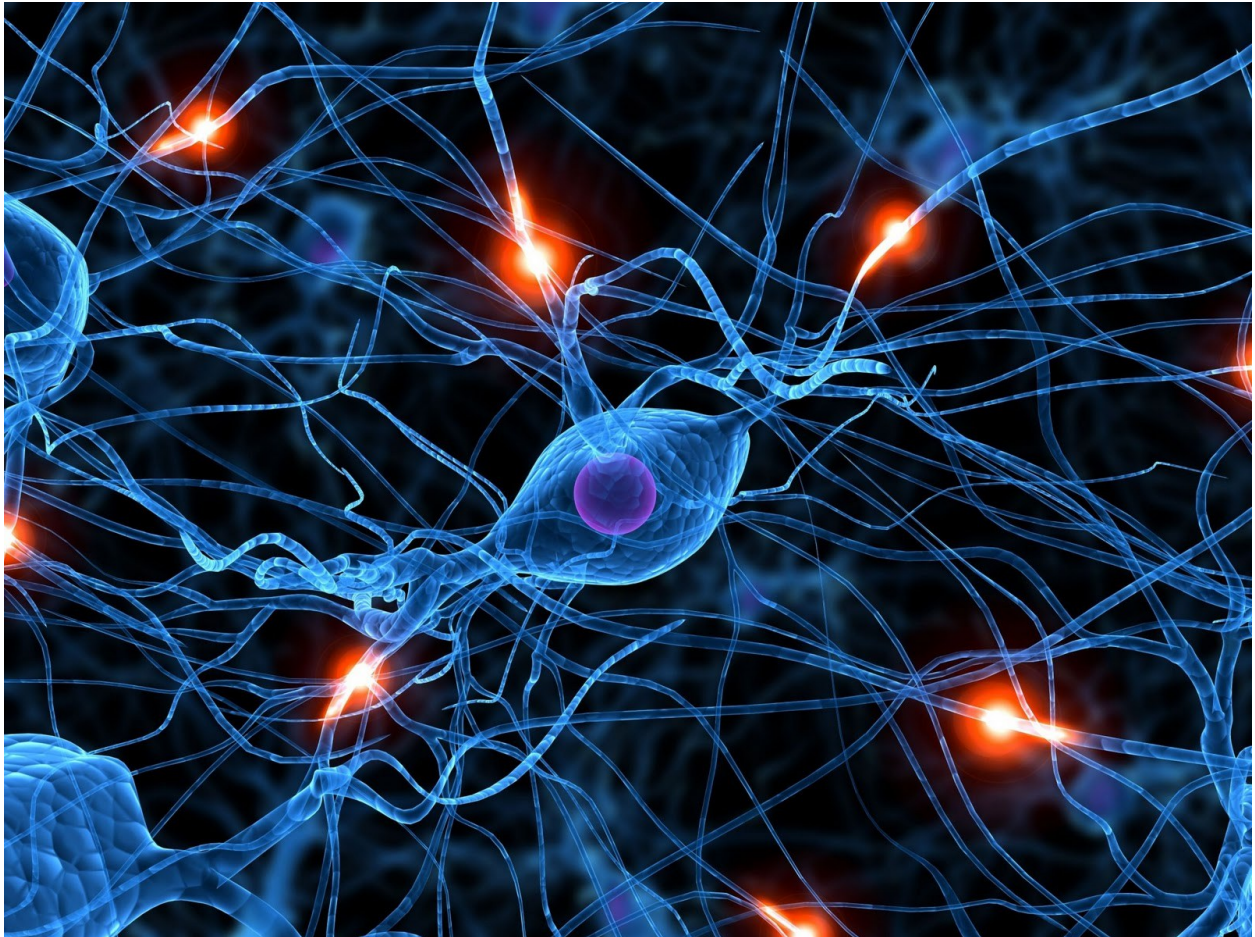


Body Charge: *experimenting with electric force fields and the human body towards the advancement of immersive and interactive electronic art*



3D Simulation of Neurons In The Human Brain

(http://4.bp.blogspot.com/-BiiZ0h_6vIk/TV0uv8J48VI/AAAAAAAAAF7I/-DPKO-6heJc/s1600/RedNeuronal.jpg)

*INDI 829A
To: Dr. Bill Vorn
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Saturday, January 05, 2013*

Introduction

Our human body has the amazing ability to conduct and control electricity through complex and dynamically changing bio-electrically charged neurological networks. Amazingly, we are somehow able to 'will' our neurology into performing the actions of the body while simultaneously receiving and transcoding information through our sensory apparatus. We understand the nature of electricity to a significant degree and there have also been advances in bio-neurology and psychology. However, the human conscious condition remains somewhat of a mystery, because we have not identified the precise mechanisms whereby we transform our will into electrical signals. Perhaps we trigger electrical actions from our 'pre-brain' conscious 'self' or 'mind' and we somehow make our metaphysical intention a physical reality. However, we do not know enough about the theoretically existing 'mind' to prove it.

I propose, as our understanding of the mind unfolds, that we will be making electronic artworks that use the electric force fields our 'pre-brain' conscious mind - just as we would use paint to make a painting. However, this proposition can only be accomplished by developing new ways of understanding and interacting with the human body's electrical forces. Therefore, in this study, I will conduct a series of experiments using electric forces and the human body. I have attempted to conduct experiments that investigate basic interactions between the human body and electrical forces in order to build a foundation for future research. In addition, each experiment is designed to simultaneously provide more immediate practical interactive art applications.

Background & Overview

When working with paint, it is important to understand the nature of paint. In this way, an artist's becomes more capable of skillfully painting something. Similarly, when working with electric force (literally) as the creative substance of an interactive artwork, it is important to understand the nature of the electric force. It is particularly important to comprehend that in our so called 'knowledge era', we have yet to reach a holistic or complete understanding of force or the concept of electricity. It is therefore important to conduct a brief overview of our current understanding and representations of force and electricity, before we devise experiments moving the field forward.

Force

A simple understanding of force can be illustrated in the example of throwing and catching a ball. Artists need to know about force because artworks use forces of all kinds. Science has given 'physical' forces descriptions, dependent on the scale of the object experiencing a force. When a particle is small enough (on the atomic level) we tend to describe things in terms of the 'nuclear' forces that dominate atomic interactions. When a body is comprised of many atoms, such as a human body or a car the electromagnetic forces seem to dominate the discussion of force interactions. Finally, when dealing with planets, as we scale up to the heavens, we describe things in terms of the gravitational forces (that dominate cosmic interactions) [1].

Descriptions of forces in the universe may vary depending on the scale we observe, but the core concepts of attraction, repulsion, balance and movement are universal to all descriptions of force. "It's a great beauty that electricity acts in a way that is very parallel to the way that gravity works"[2]. Although "gravity never repels, it only attracts"[2] and we believe that "electric forces are way more powerful than gravitational forces" [2]. This might have something to do with the fact that these observations are made on tremendously different scales and the physical nature of things tends to morph when scales are dramatically shifted. This has been recently proven with discussions of quantum physics and relativity. The only difference in the commonly used calculations of the gravitational force and the electromagnetic force is the gravitational constant from Newton's law and the electromagnetic constant from Coulomb's law respectively. So we dictate the force constants but the derivations are more or less the same and therefore the fundamental rules of these force interactions are the same, even when abstracted by the math.

Gravitational Force Calculation

$$F = G \frac{m_1 m_2}{r^2}$$

Where **G** is the gravitational constant and where **F** (force) is gravitational

Electromagnetic Force Calculation

$$F = K \frac{Q_a Q_b}{r^2}$$

Where **K** is the electromagnetic constant and where **F** (force) is electromagnetic

When we look at the visual representations of a point in a given electric field drawing, we see that the closer you are to the field of attraction, the more the force is observed [2]. This is also true of 'gravitational' and 'atomic' forces. "You have to be infinitely far away from a given force field in order for it to have a force of zero, at least in principle"[1]. This means that all forces act in almost identical ways, yet we describe the forces specific to the scale classifications that we give them, rather than describing all force as 'force' and then adding the variable 'scale' to our equations. What I feel this has done inadvertently, is given us the illusion that forces operate independently of one another.

Another problem is that we have divided 'force' into categories for the purpose of explaining specific natural phenomena in our universe. This has, albeit unintentionally, resulted in a tendency for us to calculate and consider forces as separate and therefore not interacting or co-depending. In fact, all things in the universe are connected in one way or another. Therefore, any representation of a specific force 'type' of force is an abstraction specific to observations of a given phenomenon. We tend to manifest these abstract representations of force to help us understand and use force for specific applications. The problem with this logic is that we reduce our true potential understanding of the universe and its network of forces (if, in fact, there is more than one) to specific instances of theoretically, mathematically derived, expressions.

We have a tendency to focus on what we are trying to do with a given 'force'. This technique works, or we would not have computers and space travel, but it is still inherently blinding us to the new, potentially magnanimous realities of force in the universe. For example, we can observe many 'mind' forces that have not yet been honored with their own mathematical formulas and I will cover some of these 'forces' below in: *Acknowledging Invisible forces of the 'mind'*

Additionally, I propose that we create categories of force in accordance with a relative comparison to our human scale. The fact that we perceive through our scale (as this is where we seemingly exists) means that we have a propensity to make conceptual divisions based on our body. I posit that we do

this so that we may process and make use of concepts of force as relates to the practical applications of our daily life. However, this is problematic because, we develop concepts to explain the universe as it relates to ourselves, and not to simply describe it, as it were. Science has proposed that there is a 'strong' (nuclear) force and it is hundreds of times more powerful than the electromagnetic force, and the gravitational force is the weakest. So the smaller something gets the stronger it is. Again I feel we are observing relative strength based on magnification despite obviously ignoring the drastic reduction in magnitude scale (as it relates to our own). We are not really accounting for the associated space-time distortions that occur on the many magnitudes of these scale movements. We have to bear in mind that perceptions are being projected up to the macro and onto the micro from the origin point of the human mind. The 'properties' of movement and magnitude are described differently as the scales of things change. For example, micro-organisms move tremendously 'faster' relative to our human scales and things in the human scale move 'faster' relative to cosmic bodies but all of these observations are being processed through the concept of 'speed' whereby the reference point is the human scale. Of course all of these distinctions have intense mathematical and qualitative scientific reasoning and representations for practical reasons. I am not making broad dismissals of the physical sciences, but I am concerned that our perceptual boundaries may prevent us from perceiving a more holistic notion of force and thereby limit our ability to manifest new interactions between all force and the human mind. These abstractions in the concepts of force are problematic and categorically distort the possibility of identifying a holistic, cohesive or somehow interdependent system of force(s).

I only mention these problems in brief because I suspect that a paradigm shift in our understanding of force is required in order for artists to unlock the secrets of the human body force - which we have been inadvertently working with since the first work of art was manifested.

Complex methods and abstractions are helpful but we might also be able to make more rudimentary observations of force. For example, by looking at figure 1 to 6 we can assert that force networks have some kind of intrinsically observable similarity. This observation is not in keeping with our typically abstract methodological codifications and representations of force. Instead, it is a visual correlation between a series of separate yet seemingly connected systems. There are no mathematical derivations, yet this side by side objective visual comparison of the different force networks obviously look very similar (figures 1-6).

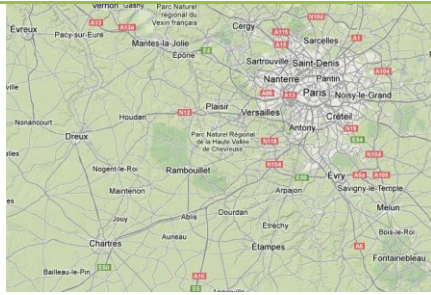


Figure 1: A road map [3]

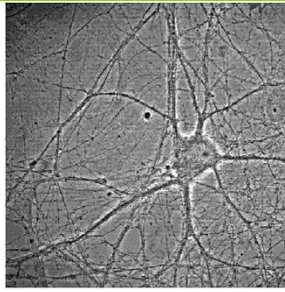


Figure 2: A neuron in culture [4]



Figure 3: Close up of a leaf [5]



Figure 4: Lightning [6]



Figure 5: Cardio vascular system part [7]



Figure 6: A tree [8]

This elementary observation is a reminder of how there are in fact very ‘simple’ connections we can make and yet extremely complex concepts can be derived when making connections between the forces of the universe. If one requires a more mathematical or qualitative explanation for these somewhat quantitative visual correlations (of the connectedness of the forces in the universe), one only need look at the Fibonacci sequence. The Fibonacci sequence and the resulting golden ratio connect so many seemingly separate things in the known universe. Defining all force is obviously beyond the scope of this paper. I simply want to begin by demonstrating that we do not understand ‘force’, ‘electrical force’ or the human body force as much as we may need to in order to make art with the substance of electricity. It is therefore, important that we experiment with electricity and the human body.

Electric Force

Now that we have taken an extremely brief overview of how we understand and represent force, I turn focus to the electrical force. Electricity is the defining element of our modern era. “Light itself is an

electromagnetic phenomenon, as radio waves are "[1] and "all chemical reactions exist because of electricity." [1]

For the time being, our common understanding of the universe is limited to the study of 'physical' material, although again quantum physics is challenging this notion. Nevertheless, we commonly begin learning about electricity as it relates to charged particles of physical matter (atoms). We abstractly describe electricity as electrically charged particles that move around passing charges from one body to another. Accordingly, electrons have a so called 'negative charge' and protons a 'positive charge'. The more conductive a material is, the more 'free electrons' are available (that are not bound to a given materials atoms) and they can move freely about - thereby carrying a charge. [1]

We have concluded that electrons move towards polar opposites and therefore, "negative attracts negative, positive attracts positive", each repel one another and therefore, oppositely charged bodies are forced to one another if they are free to move [1]. This phenomenon has been called 'induction'[1]. Most of us have at one point or another witnessed the phenomena by rubbing a balloon on our sweater or hair and sticking it to the wall - this is because friction causes electrical charge. [1] However, we have also seen the concept of induction manifest in magnets, although that is 'magnetism' and we are talking about 'electricity' here. Additionally, when bodies come into contact, they exchange their charge and eventually neutralize their charge differential. It should also be mentioned that electricity and magnetism are intrinsically connected and the movement of electricity causes magnetic fields to form (and vice versa). Nevertheless, distinct divisions are made and categories formed and practical applications manifested. We could spend a lifetime in discussion of the currently observed properties of the electrical and magnetic forces and our abstract rationalizations of what is occurring so that we can produce practical applications for their use. However, all I am concerned with covering here is the idea that 'electricity' is an abstract concept that can help us understand the movement of certain forces in the human body but it is not comprehensive or complete. In the coming sections I will deal with how this applies to the human body and creative electronic art applications.

Electric force fields

Understanding electricity may be as simple as plugging in a light. We can easily deduce that electricity is passing through the conductive wire to an element in the light bulb, and, to make a long story short, we have light. This movement of force is easy to understand because we have a way of observing the path that the force takes. Understanding force fields is complicated by the fact that we cannot easily observe

the path that the force takes because it is invisible and travels dynamically, everywhere. Science has many names for force fields like: radiation, electrical fields, magnetic fields, electromagnetic fields, electrostatic fields, radio waves, cosmic radiation etc.

Again, it is important to recognize that these abstract names are the foundations of methodological vehicles for understanding these invisible forces as they relate to specific applications. However, the core concepts of force remain constant throughout the known universe. Here, I only add to the previous section on electric force by stating that electromagnetic forces can travel through open air, and do not require dense metallic conductive wire to carry a charge from place to place. With the right understanding of frequency and charge, we can move electricity through open air. A basic example of this is seen in lightning strikes but a more complex example can be illustrated by the transmission of 'wirelessly electricity' [9]. This brief conceptual overview of electric force fields will come in handy when understanding the experiments conducted in this study.

Electric force and the human body

Now that we have briefly conducted an overview of force, electricity and electric force fields, I turn to the human body. In order for any technology to be useful to an artist, there must be practical application that can apply to the human body or mind in the form of some kind of sensorial, tactile, haptic or energy interaction. In other words, a force exchange must occur. Since the purpose of this study is the advancement of the interactive electronic arts, we will look at how electricity moves through and interacts with our body. Then we will look at currently used technology involving the human body's electrical activity, and finally I will cover my own experiments that attempt to provide practical applications for the electronic arts.

Massive electric forces can move through our body

It is amazing how much electrical energy can pass right through the human body. Most people have come across the countless survival tales, told by survivors of lightning strikes [10]. There is even an ongoing database at: <http://www.struckbylightning.org>. Of course, people who experience these epic events may survive but not unscathed. "Holle and López (2003) made an assessment of the worldwide impact of lightning, and concluded that 24,000 deaths and 240,000 injuries occur per year" [11]. Note however, that the point I am focused on illustrating here, is that most people survive. Lightning strikes

can carry up to millions of volts. Lightning strikes have “associated electric and magnetic fields measured 2 km away”[12].

“When the current is discharged, it is accompanied by a flash containing millions of volts of electricity. This is a huge amount of energy, and the surrounding air is heated up to 54,000° Fahrenheit, five times hotter than the surface temperature of the Sun. The rapidly expanding heated air also produces tremendous shock waves, which become audible as the sound of thunder.” [13]

Yet we can survive these unimaginably epic force events, simply if the force has a way of ‘moving through’ us (to ground). There is no all-encompassing theory that fully describes why lightning strikes occur [13]. I personally believe that the charge differential between the earth and the ionosphere has something to do with it, but obviously this is beyond the scope of this paper. I simply want to point out that we are dealing with powers of epic planetary proportions – which we can be immersed in and survive.

Even more unbelievable, yet openly proven, are the stories of people who can pass extremely high electrical currents through their body under controlled environments. ‘Jose Ayala The Electric Man [14] and ‘The Siberian Electric Man’ [15] are both famous for performances where they pass enough current through their bodies to operate house hold and even light industrial electronics. Without any doubt, electrical forces can easily pass through the body, and in some cases at unbelievably high levels.

These examples are not intended to come to any conclusion or speculation about what is happening with the electrical current that passes through our bodies. Rather, I am attempting to broaden the discussion of ‘body-force’ in the electronic arts to a point where we can imagine that there are unexplained and potentially magnanimous possibilities available to us via passing forces through our body. Therefore, broadly understanding the human body’s coexistence with electricity will add another important element to the foundation I am building for the experiments I conduct in the paper.

We control our body with internal electric forces

Amazingly, we are able to control electricity in our body throughout our nervous system. “The nervous system is the most complex system of the human body” and “the nervous system is never at a state of full rest” [16]. Feelings and sensations are derived from electrical impulses in the nervous system and even conscious contemplation or logical cognitive processes could be attributed to our electromagnetic

consciousness [17]. Even without our 'awareness', our 'unconscious' nervous activity, like the heart beating, our eyes blinking and auto responses to smells like pheromones, are all occurring because of electromagnetic forces moving through the nervous system. Therefore, all art, ever produced, is dependent on the electrical forces of the body, for its conception and reception.

"A fully functioning brain can produce as much as 10 watts of power ... and this is a speculation"[18]. Neurologists posit that electrical energy is produced by the body in neuron cells throughout the nervous system. Neurons have high levels of positively charged potassium ions (particles of matter), while outside of the cell there are low levels of positively charged potassium ions and the opposite is true of positively charged sodium ions [19]. The semipermeable membrane of neuron cells allows for the bilateral movement of both potassium and sodium ions that are positively charged. At about 70mV neurons reach resting potential [19], whereby the electrical charge of the inside and outside is balanced or neutralized. Therefore, we believe that the human '**body charge**' is produced by differentials in the charge potential of physical elements in the body. However, even if we believe this to be completely true, it does not account for our ability to control the charge. This widely disseminated explanation rather elucidates on the matter of how our biological organism manufactures electrical power, not how our illusive mind controls such power.

Neurons are sometimes categorized by their electrical activity. Unipolar neurons act like diodes, bipolar neurons act like wires and multipolar neurons (the most fascinating of the three for me) act like switches. Neurons have also been described by their functional biological properties such as 'sensory neurons', 'motor neurons' or 'association neuron' [19].

Observing the movement of electric force in the body produces fascinating results. To some degree we are even able to understand our automatic neurological reactions to our environment and in other cases produce usable data for cognition research. However, we have yet to account for the precise 'control' mechanism of our mind that allows our pre-brain conscious 'sole' to switch on and off electric flow or charge movements, so that we ultimately chose to believe or not to believe something.

Scholarly endeavor is making great progress in understanding the production and movement of electrical forces in the body. For example, using principal diffusion direction [20] from the brains connections, the recently developed 'Human Connectome Project' [21] (Figure:7 Below) reveals an open tunnel in the middle of our brains electrical movements, that I suspect would naturally produce a fascinating series of controlled electromagnetic fields.

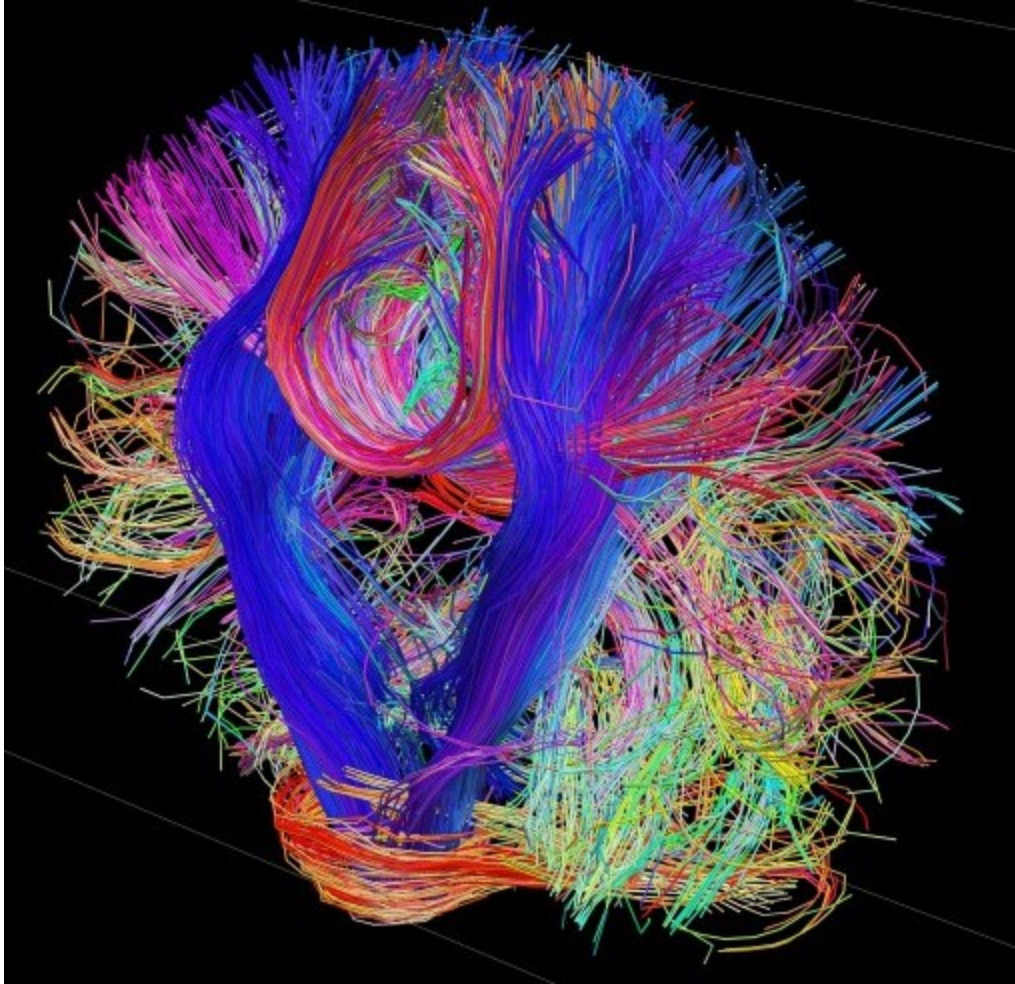


Figure 7: Human Connectome Project

Controlling the body with external electrical forces

One of the more fascinating observations, now common place, is that electrical impulses can control the body. A transcutaneous electrical nerve stimulation (TENS) machine produces an electrical current that is sent into the body via electrodes and it causes muscles to convulse. The electrical current ‘piggy backs’ on our own nerves and triggers action, in a similar way to our nervous system. There are controversial research claims that these machines provide practical medical benefits and some even “conclude that for patients with chronic low back pain, treatment with TENS is no more effective than treatment with a placebo” [22]. What is important, for the purpose of the background I am building, is to note that electrical forces can be applied to the body to control it. Granted, the technology is both

controversial and in its early stages of development, but theoretically, all of the movements of a human body could be aided or assisted, and maybe even controlled by a computer. Of course, and once again, elaboration on these points is out of scope, but I feel it important to note that we can 'plug in' to our nervous system and pass electrical current into our bodies in meaningful ways that can control our body.

TENS machines, literally apply a current to the body via electrodes attached to the surface of the skin via a conductive adhesive or jelly. However, in the experiments that I conduct below, I will demonstrate that it is also possible to plug into the body's electrical fields without making direct contact with the skin (although I have yet to trigger events in the mind as the TENS machine triggers events in the body).

Recording and measuring electrical forces in the human body

Electroencephalography: or EEG has become so commonplace that there readily available EEG toys like the 'Star Wars Force Trainer' or 'Mattel's Mind Flex game'. There are a variety of inexpensive commercially available EEG devices, such as the 'Emotive' EEG system. There is also an open source hardware and software EEG project that is advanced enough to use 'positive' or 'active' electrodes. A company called NeuroSky has even developed a kind of social behavior prosthetic that consists of an EEG "brain-controlled tail that wags with your mood"[23].

EEG technology is relatively simple. "EEG signals are measured in cycles per second or Hertz" [18] of the electrical signals of the brain. These electrical signals have been extensively studied and we have come to roughly understand that there, "are levels of arousal characteristic of brain wave patterns, as recorded by EEG signals" [16]. We understand these basic levels to range from sleeping to action, whereby the wave form changes from low (2Hz) to high (30Hz) frequencies respectively [16]. The lower frequency ranges have higher amplitudes and the higher frequencies have lower amplitudes. The brains electrical expressions as recorded via EEG signals are codependent on the relative fluctuations of the frequency and amplitude of the electrical activity in and around the scalp. Anomalies such as high frequency signals that also have a high amplitudes are characteristic of a seizures [16].

Understanding that variable frequencies are expressed during different states of 'mind' is important background to the experiments I conduct below, and although I have not gone as far as using specific frequency controls in my experiments, it is important to understand that the body expresses different electrical frequencies as relates to different states of activity that have been statistically associated with states of 'mind'. Unfortunately, EEG can only accurately and reliably indicate levels of activity that

directly correspond to the state of arousal of the body (as opposed to distinct emotional states). For example, someone might be very 'sad' yet on a tread mill or roller coaster, and the EEG reading may not statistically output 'sadness'.

Despite being readily available and somewhat useful, EEG technology is imperfect and there are several problems with using EEG to assess the condition of our mind. In the first place, when neuroscientists discuss the anatomy of the nervous system, there is a tendency for their understanding to be based on cartographic mappings of the brain; as though we are on some kind of physical expedition to map the planet of the mind. Localized electric signals are recorded using EEG electrodes placed around the scalp, and because of the overarching cartographic logic, observations are usually attributed to the sections of the brain being observed. Local signals and their associated region of the brain take precedence, rather than the total, net electrical force of the body as it is generated and expressed throughout the entire body. In addition, biologists are not experts on electromagnetism and science needs to embrace a holistic methodology of interdisciplinary exploration when approaching the topic of the human electrical force. Furthermore, EEG devices are problematic in that they produce electromagnetic interference or feedback (because they also conduct electricity) and therefore are less than perfectly accurate in the best of circumstances.

The galvanic skin response: or GSR is another very well-known technology for recording and measuring the body's interaction with electrical forces. A GSR machine "measures skin conductivity" and "has gone through many phases of interest and rejection since the early 1900's" [24]. GSR electrical signals are sent into the body via an 'active' or anode electrode (~1.5V 200 μ A) and collected from the body via a 'passive' or cathode electrode. The level of electrical current that passes through the body is measured and a difference in skin conductance is caused by the level of sweat emitted by our sweat glands because more sweat produces more resistance to the current passing through.

EEG and GSR technology have become commonplace in the arts, and there are a wide range of works such as "The Static Organ"[25], "Brainfilter"[26], "Thinking Cap" [27] and "Mind Pool" [28], just to name a hand full off of the very tip of an iceberg. The practical applications are evident, but ultimately we must remain cautious. We cannot assume we have mastered or even successfully built the foundations for any of the aforementioned technologies, simply because we have found some practical applications for it or because it has become commonplace.

Recording and measuring the body's electrical forces via these devices still requires a certain active conscious interaction between the participant and the electronic artwork. The interaction demands that we adapt ourselves to the technology and change our normal physiological responses so that we can assimilate immersion and gain awareness of the observable results being outputted by the art machines. This cycle of events is commonly celebrated as biofeedback. However, our attention is forced to a specific autonomic bio-physiological event in our body, that when we focus on, or become aware of, we can interact with or control. Biofeedback is therefore highly practical but ultimately problematic because it requires our active, continuous focus in order to achieve a practical level of interaction and we are always bending our will to the limitations of the technology. The EEG and GSR interaction cycles are based largely on the human participant's ability to intuitively 'know', 'sense' or 'feel' their autonomic responses. Thus, our ability to adapt to the limitations of the technology can cause delayed feedback and inaccurate immersive results. What is ultimately required is a system that is more intuitive, auto-responsive and adaptive, that has the capacity to learn and dynamically interact with participants electrical forces in a kind of 'electro-ergonomic' way.

Acknowledging Invisible forces of the 'mind'

In this section, I would like to make note of the fact that we can excogitate reactions from our mind without knowing the exact physical mechanisms involved and this will prove useful when thinking about the experiments I have conducted. The following is a summary of research that illustrates our ability to consistently manipulate the mind, despite a knowledge gap in the exact mechanisms involved. I should add that we have a tendency to be tempted by the metaphysical and the imaginary, when dealing with the unknown elements of the mind and I want to make clear that this is not my intention. I have and will therefore only focus on empirically observable research whereby experiments were conducted and studied published in reputable, double blinded peer reviewed academic journals. I also feel that these studies were conducted in the same spirit to my own, in that they are somewhat undefined, initially unbelievable, yet observable phenomena.

Controlling our brain using frequencies

We already looked at the frequencies expressed by brain wave patterns as recorded by the electroencephalogram. We can amazingly reverse engineer these frequencies and control the mind (in effect) by using our optical and audible sensory apparatus to trigger electrical activity in the brain via controlled wave patterns. In other words, by stimulating the eyes and ears, we can induce known

electrical signal patterns in our neurology that get sent to the brain and controls the state of our perception. A 'sound and light machine' produces intermittent "photic-stimulations ... using flashing lights"[30] combined with "binaural beat frequencies at the speakers"[31] to create a frequency differential between the left and right ears and eyes, thereby causing a participant to hallucinate.

Brion Gysin, was the first electronic artist to use such stroboscopic stimulation in a work of art called the "Dreammachine"[32] in the 1960's. Sound and light machines cause us to become disoriented by the fact that our brains are used to interpreting signals that have been learned and encoded into the neuropath-ways our of neurology. These imputes, that we normally receive, can be thought of as the total aggregated audio-visual, periphery and sensory activity, summed up by a collective signal that we interpret. The oscillating frequencies of a sound and light machine disorient us and propel the brain into an audio-visual hallucination because there is a disruption to our normal frequencies. This causes disjunctive sensations that we are not used to interpreting, and so the mind begins to invent all manner of colors, lights and even fully formed day-dream narratives in an attempt to transcode the unfamiliar frequencies. I have personally experienced the sound and light machine for prolonged periods and I hypothesize a frequency magnification is generated based upon similar principles demonstrated by Tesla mechanical oscillator generator [33]. Rather than simply processing the disjunctive frequencies that are given to the brain, our neurology seems to manufacture a resonant sum of the frequencies and therefore magnifies the signal. The affect is literally a total out of body experience.

Messages from the mind

In the first place, I would like to make an important, yet commonly overlooked distinction between the brain and the mind. The brain is a bio-electro-mechanical machine and the mind is the mysterious controller of said machine. We are coming close to having a fairly well built and comprehensive idea about how the brain works, yet we know little to nothing about the mechanics of the mind. That being said, we are able to study the mind by conducting controlled experiments with consistent observations, which then lead us to reasonably trustworthy conclusions as to what is happening in the mind.

For example, Dr. Rupert Sheldrake has quantified what is known as 'the sense of being stared at'[34]. Everyone is likely to have experience this sensation that someone is watching them, and looking around a room, they actually find that someone was. However, until Sheldrake developed the research, there were no controlled experiments that could prove the existence of the 'sense'. His 'scientific method' driven experiments concluded that there is in fact a 'sense of being stared at' and he has the numbers to

prove it. Therefore, we gain the knowledge that this unexplainable sense exists, and we can even stipulate a probability of occurrence based on when it is most observed, but as of yet we have no way of building a conclusive case as to how it works.

Controlling the physical brain with the willpower of the mind

A more practical and highly controlled example of the apparent force of the mind, can be seen in the work of Dr. Christopher deCharms who uses functional magnetic resonance imaging (fMRI) to 'cure' chronic pain [35]. What he does is simply show the patient a real time image of their brain activity, specifically the areas of their brain that are being triggered when they experience their pain. He is then able to simply ask them to - 'will the pain away'. He has had very promising results and has built a biofeedback environment that has empowered his patients with the capacity to control, and 'rewire' their neural pathways, simply by offering them a view of what is going on in their physical brain. Again, we have no idea how the mind is capable of such amazing feats and yet it is proven.

Interfacing the imaginary and the real or the mind and the body

Dr. Vilayanur Ramachandran's research on brain damage and chronic pain [36], as experienced in the sinesthesia of phantom limbs, is another good example of the mind at work above the brain. In the first place, the fact that amputees commonly experience phantom limb at all is a feat of the mind. He is able to use a series of mirrors and controlled repetitive exercises to help patients rewire their brain using their mind and overcome the common experience of having pain in their amputated limbs. Both deCharms and Ramachandran are scholars of neurology and so they have posited some logical reasoning for the occurrences they have observed, but neither of them have ventured so far as to claim they know the exact controller mechanism of the mind making their mind-hacks possible. We have these amazing, scientifically proven studies, which are repeatable under controlled environments, yet ultimately unexplainable.

Telepathy proven

My favorite examples of this genre of empirically observable, yet mysterious experimentation of the mind are Dr. Michael Persinger's experiments. Persinger seems preoccupied with the idea that we can 'eliminate secrets', but notwithstanding his motives, he has developed an amazing experiment that practically proves telepathy by using complex magnetic fields. He uses magnetic field induced stimulations of the brain that are theoretically triggered by the invisible forces of the mind. Of course,

and as I have demonstrated, the force of 'electricity' is intrinsically connected with the force of 'magnetism' and has been derived 'electromagnetism'. His experiments include correlational studies of telepathy in the dream state and 'remote viewing'. Persinger builds tools to train the mind to recognize and utilize seemingly metaphysical events [37]. I am specifically interested in the magnetic field technology that makes most of his more comprehensively provable experiments possible.

"If you have one person here, and one person here, and you generate a condition that produces the same kind of magnetic field ... what you find is whatever that person is looking at, the other person can draw accurately." [37]

By artificially inducing controlled magnetic fields around the scalp of two participants, Persinger is able to hyper-induce a type of 'collective' or 'shared consciousness', between the two minds. His most compelling example to date is when he puts two subjects in separate dark rooms with their eyes closed and exposes them to the same magnetic field, and then flashes a light in only one room, yet both subjects report seeing it at the same time.

This and the other examples I have covered not only demonstrate the power of the undiscovered elements of the mind, but also produce the foundation for a practical applications in several fields. In keeping with this philosophy I present the following experiments.

Experiments & Results

The following are a series of experiments I have designed to study basic interactions of electromagnetic forces and the human body. The secondary purpose of these experiments is to develop practical immersive and interactive electronic art applications. The experiments were constructed around the concept of energy inputs and outputs whereby the human body is subjected to electromagnetic force (inputs) and the resulting electromagnetic output from the body are observed.

Experiment 1: Does the human body absorb electromagnetic force?

This first experiment is designed to determine if the human body is in fact absorbing electromagnetic forces. I attempt to measure how much force is being absorbed and to roughly determine the human bodies 'absorptive capacity' for electromagnetic energy.

I use a 'plasma ball' device, which acts quite like a self-grounding Tesla coil, to generate the EMF force. Plasma balls were also initially invented by Tesla (although he called it the 'inert gas discharge tube'). A plasma ball is essentially an open air transformer and current oscillator that produces electrical discharges from a cathode installed in the middle of a glass bulb containing neon and argon gas. When the electromagnetic emissions (in the radio frequency range) pass through the glass 'bulb' a visual of the discharges is rendered in the electro-excited neon and argon gas florescence (Figure 8). Basically, instead of shooting lightning-like bolts of ionized air particles (plasma charges) of super-high voltage through the air, as a tesla coils do, the plasma ball contains the electrical event within relatively safer lower energy device. However, the plasma ball still emits a very high dose of electromagnetic force. Therefore, I use the plasma ball as my EMF emitter.

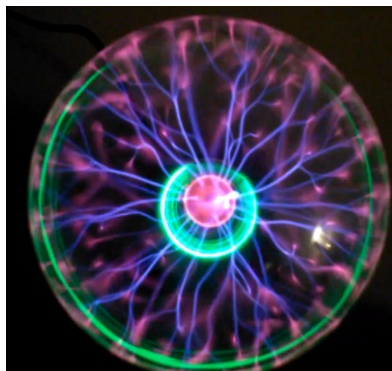


Figure 8: Plasma Ball

Firstly, I determined the level of EMF emissions coming from the specific eight inch plasma ball I use with an off the shelf EMF detector. The EMF detector provides a measurement in Hertz and has a sensitivity of ~1 Hertz. I tested the emissions at distances ranging from 30 inches to 1 inch from the plasma ball and produced the following results.

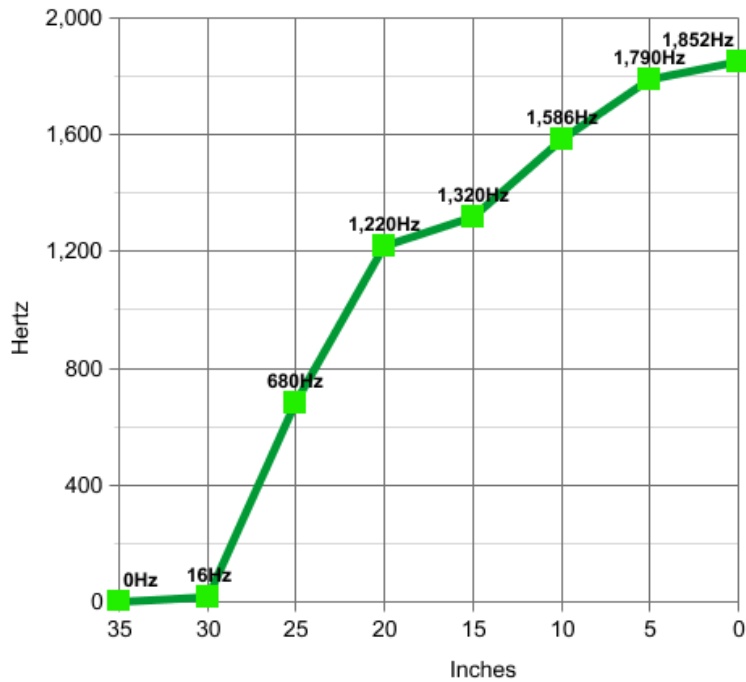


Figure 9: EMF Emissions of Plasma Ball

As figure 9 illustrates, on the high end, an eight inch plasma ball can produce over 1800Hz of EMF output.

The next step was to determine if the human body absorbs EMF energy. Firstly, I placed my hand in between the plasma ball and the EMF detector to assess if my body was interfering with the EMF signal. In addition, just to be sure that the EMF signal was not simply finding the nearest ground point, I sat on top of a rubber inflated exercise ball. In every case, when placing my hand in between the plasma ball and the EMF detector the EMF signal was significantly reduced. As a control I placed tin foil and other known conductive and non-conductive materials in between the plasma ball and the EMF detector. Relatively little EMF interference was recorded with the variety of materials I used, when compared to my body. This indicates that a live human body has a higher absorption and or interference capacity with EMF energy than the other material objects used.

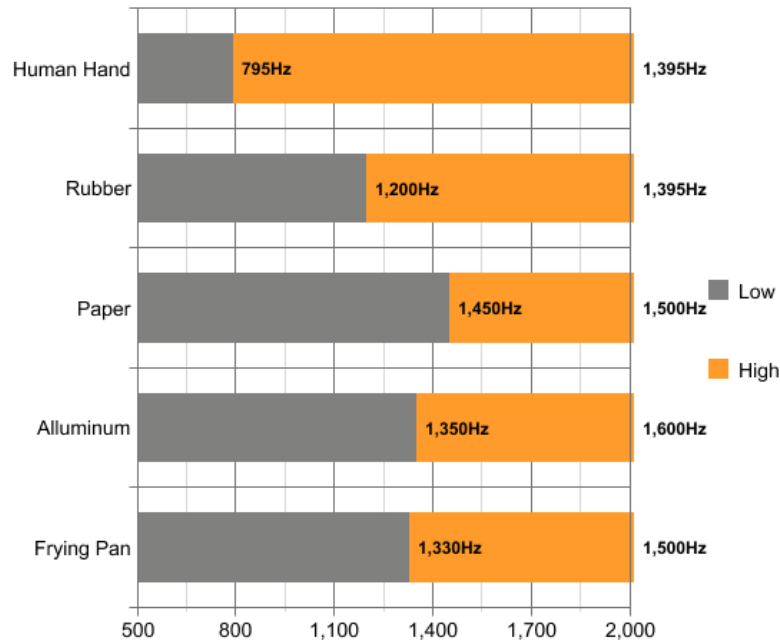


Figure 9: Relative EMF Emission Interference by various materials

Potential Practical Electronic Art Applications:

- A fairly accurate proximity detector can be made from the EMF detection point that could be designed to specifically detect the human body or a body part
- An open air cut off switch could be made to respond to the presence of a human body (as opposed to open air cut-off switches that are triggered by any interrupting body)

Experiment 2: Does electromagnetic force travel through the human body?

After observing that the human body interferes with and maybe even absorbed the EMF energy, the next step was to determine what was happening to the EMF force as it contacted the human body. I wanted to determine if the EMF forces of the body simply interfered with the EMF forces of the plasma ball or if the human body was absorbing the EMF radiation. I began by touching the plasma ball with one hand while holding the EMF detector in my other hand to determine if the EMF force was traveling through my body. The EMF detector consistently indicated an average of ~700Hz in a range of distances from 6 inches, when I held the detector closer to the plasma ball, to 30 inches when I fully extended my arms. Therefore, there was little difference between the EMF emissions seen when the EMF detector

was placed closer to the plasma ball or when my arms were fully extended. If my hands were touching and connecting the EMF emitter and the EMF detector, the force seemed to travel through my body and consistent readings were taken to illustrate this. As a control, and to ensure I was measuring the EMF signal and not some other electrical discharge, caused by direct contact with the emitter and detector, I held my hand at a distance from the plasma ball and placed the EMF detector at a distance from my hands and feet. The results showed that a consistent, albeit different, level of EMF energy was detected even with open air gaps.



Figure 10: EMF energy passing through body and being detected with open air gaps

As illustrated, the EMF signal travels through my body with relatively little loss despite any open air gaps. However, I wanted to corroborate the results with more than one EMF measurement device. Unfortunately I did not have the budget for precision EMF detection equipment, but conveniently, I accidentally discovered an alternative measurement tool to help me study the passage of EMF energy through my body.

Quite by accident, I happened to be touching the plasma ball and wanted to hear some music, so I reached for my the 3.5mm amplifier audio jack, to connect it to my laptop. I was still touching the plasma ball and a massive noise came out of the speakers. After determining that I was not electroshocked, I began to play around with the audio jack and the plasma ball. I found out that by

simply holding a 3.5mm audio jack connected to an audio amplifier (between my thumb and index finger) I could hear the EMF forces entering my body and exiting via the sound cable.



Figure 11: human body electromagnetic emissions audio amplifier

Using this new 'human body electromagnetic emissions audio amplifier' instrument, I was able to conduct a series of experiments that indicate that there is a change in frequency and amplitude when I approach a high-powered EMF emission source like the plasma ball. This means that my body is not only absorbing the EMF energy, it is also able to carry it across my body to a point where the signal intensity and frequency can be measured by audio amplifications. Essentially, my body can act like an 'EMF transceiver'. It should be noted that the audio amplification effect is most noticeable with higher EMF emissions that cause amplification of the audio signal.

Science is already well aware that the body produces a unique EMF emission, but what this research is showing is that we can 'piggy back' on the body's EMF signal, much in the way that we can 'piggy back' on our nervous system with TENS machine electrical impulses.

Potential Practical Electronic Art Applications:

- A much more accurate gesture tracking device that cross references the frequency and amplitude of a given EMF 'output' signal as it passes through the body
- Some sort of electronic musical instrument could develop, analogous to, and perhaps even in combination with, the preceding electronic Theremin

Experiment 3: Can we consciously 'sense' or 'feel' the electromagnetic force?

I'm afraid the next experiment must be taken at face value, because it is impossible for me to produce and numerical or qualitative (instrument assisted) measurement for analysis. Instead, the following is based on my testimony alone. In future it is my intention to expand the study to multiple participants, in a double blinded analysis dedicated to this specific question; can we consciously feel the electrical force?

We are aware of a phenomena known as 'electromagnetic hypersensitivity' or 'electro-hypersensitivity' which has been described as a warm, burning, tingling, prickling and even nauseating sensations [38]. Some of the claims made are obviously questionable but we have comfortably proven that; "electromagnetic sensibility as the ability to perceive electric and electromagnetic exposure" [39].

What I am interested in doing, for the purpose of this study, is designing an electronic art application for the 'feeling' or 'sensing' of EMF fields. When I was placing my hand near or on the plasma ball, in the previous experiments, I was not focused on 'feeling' the EMF field, and the sensation of being in or around the plasma balls was not strong enough that I could obviously or definitely 'feel' fields. So I decided to magnify the field. To do this, I placed two plasma balls of relatively equal EMF emissions next to each other approximately two inches apart.

I made sure that the EMF signal was in fact being amplified by repeating the first step of experiment one. Again, I place the detectors at distances ranging from 0 inches to 25 inches from the two plasma balls and recorded the EMF emissions.

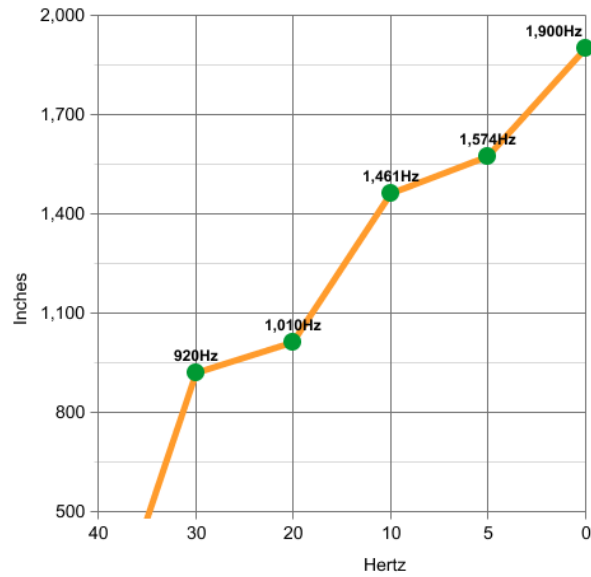


Figure 12: EMF Emissions of Two Plasma Balls

I determined that the two EMF sources or plasma balls were not grounding or absorbing one another's EMF forces and were indeed combining forces to magnify the total aggregated EMF field range. Note that this action amplified the signal but did not significantly change the EMF frequencies. However, if the plasma balls are brought close enough to one another; they begin to share the field in such a way as to homogenize their collective frequency. In other words, instead of emitting slightly different frequency ranges, as no two products are perfectly alike, they begin to emit a shared and equalized range. I then passed my hand through the gap in the middle of the two plasma balls and I was shocked to discover that I could indeed feel a tingling warm pressure in and around my hand. I was skeptical and bewildered so I repeated the experiment over the course of an afternoon.

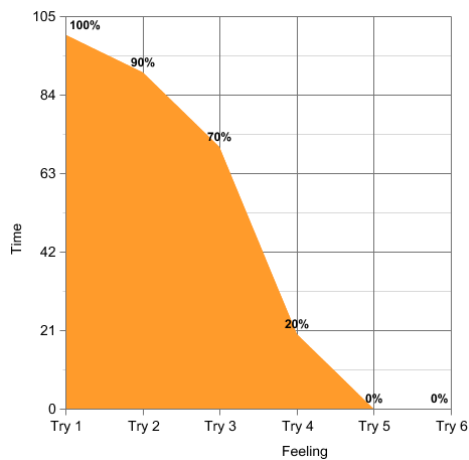


Figure 14: Force 'Feeling' Sensitivity Over Time (Minutes)



Figure 13: Passing My Hand Between Two Plasma Balls

What I discovered is that the sensation was reduced, such that, by the fourth or so test, I was not able to significantly 'feel' anything. When I repeated the experiment days later, I got very similar results. At first I could feel the field and then it passed with repetitive attempts. I can only speculate as to why this happened and we must keep in mind that this entire experiment is based on my subjective perception. I speculate that one of a few things could be happening:

1. The sensation is reduced over time because the electrical charge differential in the system of the two plasma balls and my hand or body is neutralized.
2. The sensation is reduced over time because my nervous system becomes numb to the sensation or 'used' to the sensation and perhaps even blocks it out as a defense mechanism to a foreign sensation.
3. The sensation is reduced over time because the sensations is actually generated by the hairs standing up on my hand, and once erected; the hairs no longer experience the expansion sensation that comes from standing up from the body.

Potential Practical Electronic Art Applications:

- Although this experiment is inconclusive, I speculate that exposing the human body to an amplified EMF fields can have the potential for many sensorial experiences including, but not limited to, synesthesia of presence.

Hypotheses

- **Hypothesis A:** Based on experiments 1 and 2, (with highly sensitive and controlled equipment) it may be possible to pass EMF signals through the body and use the resulting measurements (of the bodies emitted EMF signal) as a way of assessing the bodies 'action' or effect on the field.
- **Hypothesis B:** Based on experiments 1 and 2, (with highly sensitive and controlled equipment) it may be possible to measure and determine fluctuation in our body's electromagnetic 'energy field'
- **Hypothesis C:** Based on experiment 3, it may be possible to induce synesthesia of presence using EMF fields around the body
- **Hypothesis D:** Based on experiments 1,2 and 3, it is possible to build a large scale EMF immersive 'sculpture' that would project a controlled EMF field onto a human body such that multiple gestural, sensory, biofeedback and perceptual prosthetics applications could be manifested.
- **Speculative Possibilities (requiring additional research):**
 - Controlling the frequencies emitted by the EMF source can likely influence specific sensations in the body (as is seen with sound and light machines) and it is likely that the frequencies required to manipulate the bodies EMF energy will be similar to (or related to) the frequencies recorded by EEG measurements.
 - Controlling the magnetic fields around the body (thereby subjecting the body to amplified and controlled EMF energy) may provide a way of recording, codifying and transmitting the body's energy field.
 - Combining controlled magnetic fields and EMF emissions in and around the human body may allow us to pass sensations from one person to another or an artwork to a person; similar to the way that Dr. Persinger's complex magnetic fields induce remote stimulations of the mind.

Conclusions

In my opinion, the most important functional element of the mind is contained within the phenomena of electromagnetism. If we want to understand how to transmit thoughts and feelings and how to transmit energy from an art object (my long-standing goals of electronic artists) then we must come to learn how to make art with electricity as a substance, in and of itself. Electronic artists must learn how to manipulate electricity to do more than light up lights and respond to sensors. We need to sculpt the force of electromagnetism itself. We need to learn how to manipulate the force, not only from person to person as Persinger does, but from object to person - from artwork to viewer.

This is not science fiction, it is simply a study in its infancy and obviously the experiments conducted are formally inconclusive in that they require further study. However, theoreticians like Susan Pockett [17] and McFadden [29] have been researching and understanding the electromagnetic theories of consciousness for more than ten years. I speculate that we have even been able to take pictures of 'the force' using techniques like Jeremy Stolow's (SSHRC) funded 'aura photography' [40].

The challenges that artist must overcome are within the trans-disciplinary barriers of language and scholarly motivations whereby; the common goal of understanding the force phenomena of our bodies and minds is subject to practical applications in bio-medical or neurological schools of thought. As artists, we may be able to provide a holistic view to these phenomena because we are concerned with the pure essence of our emotive expression. We are therefore motivated to build tools that extract and transmit the pure force of our bodies so that we can explore our sensations and expressive potentials.

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