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Neural Proliferation using Brain stimulation Methods Intended for Pediatric Neuropsychiatric Population: A Hypothesis and Theoretical Investigation

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Abstract

It is estimated that 7 – 8 per cent of the total world population comprises of mentally disabled people further within 75 – 90 per cent are intellectually challenged. Apart from this, there is a considerable rate of children who are suffering from cognitive syndromes. Many people around the world are affected by neuropsychological disorders. Unfortunately, there are no adequate solutions for strengthening their capacity and all such methods are in the infancy stage and they are dealing with animal models. This paper will provide a bird’s view of existing solutions and the recent trends that are commercially available. In addition, we are developing a unique method that will be a promising solution for treating neuropsychological disorders. There are commerciallymany tools available to assess the rodents’ behaviour and all these systems are application specified and developed for Deep Brain Stimulation studies. A system that stimulates multiple neurons along with the reward center intended for treating intellectually challenged, neurological and psychiatric subjects and the patients with brain stroke is yet to be evolved. We are developing a system that will show a new horizon in these areas. The futuristic design of our product will lead the degraded society into light and nurture them with a life of equal standardwith others. The main challenge is to verify the system in an animal model before introducing it in humans.

Keywords; *Deep Brain Stimulation, Intracranial Self-Stimulation, Implant, Stimulations*

I. INTRODUCTION

In the study of the neural basis of behaviour, electrical stimulation of brain is an important tool. It is a fruitful technique to explore the brain-behaviour relationships. Studies show that there is a considerable response when we provide stimulations in specified regions. It is treated as one of the strongly remunerating conduct encounters, maybe it is more compelling than encouraging or sexual prizes. Self-incitement encounter which includes repetitive exercises of emphatically remunerating circuits may result in critical changes in dendritic arborization of the neurons of limbic and neocortical districts.

Intracranial self-stimulation experience helps to increase the spine, dendritic arborization and synaptic concentration and fasten neurotransmission [1]. In any case, it was suspicious this was because of a remunerating feeling or because of direct electrical incitement. A study was conducted to answer this question by Dr B. S. ShankaranaryanaRao, Dr T. Desiraju and Dr T. R.

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Raju. They found that the growth in neurons was not because of simple electric stimulation. They felt that motivation and learning were responsible for the neuronal growth[2]. So, it is a known fact that using Hebbian principal and ICSS, neural proliferation is possible. In the long run, there is a huge potential in these two principals especially in the area of mentally retarded children.

For the realization of these concepts, we have developed a model that can be applied to stitch the brain. The entire process can be called as stitching in time. By manipulating events in time, connections may be brought about in the brain, as the brain has the tendency to wire together the neurons which are triggered in quick succession.

To make such a connection, a sequence generator or 'STITCHER in time' can be used. The vital stimulations shall be applied to the appropriate parts of the brain with the required speed. Thus various parts of the brain can bring closer in time. So this is called as 'stitch in time' of the brain. Usually, doctors stitch in space, bringing two parts closer in space, but here it is stitch in time bringing two parts closer in time.

In order to validate this model, first, we have to try this in an animal model. Here, in this work, we will be seeing how this model works in animal and how we will be fixing this model. Although there are several models similar to this one are available, they can't be used for long and they still lack appropriate technologies for the complete realization of our concept.

Here we are proposing a complete system along with an implantable device where it delivers multi neuron stimulation and the whole system can be controlled by using a mobile application. Although it is modelled for neurological and psychiatric patients, we need to have a methodical study of animal models. This model using advanced components in stimulator so that it will remain as low powered with long life at the same time it will be cheaper in comparison with the alternative models those are present in the market.

II. MATERIALS AND METHODS

Here we will be going through some modern techniques of interacting with a brain which could be used in the treatment of Mentally Challenged Children. Some broad aspects of interacting methodologies are as follows. If some parts of the brain are affected, there can be multiple ways of solving the problem. Some solutions include: (1) making the corresponding brain part on the other half to take up the job, (2) making the adjacent areas of the affected part to take up the job, (3) replacing the affected part with some transplanted tissues, (4) replacing the affected portion with new neurons using stem cells, (5) equipping the existing neurons at the same spot or nearby spots to grow, multiply and make proper connections by natural and artificial stimulation method or (6) by allowing a chip to do the work of the affected portions. "Direct control of paralyzed muscles by cortical neurons"[3] is made possible now. "Long-standing motor cortex plasticity is induced by an electronic neural implant"[4].

2.1 Transplantation of Neurons

There are some reported cases where the transplanted neurons have survived. If some cells can survive, it gives hope to think along that line. An oligodendrocyte Transplantation cell line action prompts more extensive myelination in myelin-inadequate rodent spinal line, CG4 oligodendrocyte forebears climbed to 7 mm with the dorsal segment. At that point, they are part up and myelinated different axons 2 weeks in the wake of joining. In myelin-insufficient rodents, wide movement was implied by recoloring for a beta-galactosidase action of the flawless spinal string of typical myelinated rodents and after a non-intrusive joining method. In this way, oligodendrocyte forebears can keep up their capacity to relocate and myelinate axons in

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vivo after different entries in vitro[5]. Transplanted embryonic dopamine neurons help to treat Parkinson disease[6].

2.2 Stem Cell Therapy

Stem cells placed at the required spot, sprout to be healthy new cells. They make new connections with existing ones. With the transplantation of grown-up rodent hippocampus-determined neuronal immature microorganisms supplanting the retina which is harmed, they were bound together into host retina[7]. Some electrical stimulations will surely accelerate the growth/spreading of the stem cells too. The brain seems to be adjusting/taking corrective steps, in cases where the occurrence pattern is highly random/unpredictable[8]. This may be explained as the brain makes the corrections faster in order to be ready for any unpredictable eventuality.

2.3 Transcranial Magnetic Stimulation(TMS)

The principle behind the TMS method is to stimulate the brain in a non-invasive way by the magnetic effect. As the neuron in the braindance to the tune of the magnetic changes, they acquire positive qualities. TMS has the advantage of being non-invasive. So it is easy to take up and it is rather cheap. There are some small side effects in some people in certain frequency ranges. But those side effects could be countered properly[9].

There are no reports of neurogenesis as a result of TMS. Also, there are no reports of the sustaining of the effects for long. At the same time, reports about continued application of TMS is not available. One great surprising aspect of TMS is its non – volitional, motivational, involvement oriented aspects. If it had any motivational aspects, even in placebo tests, the subjects would have shown improvement in abilities[10]. Thus this is an objective method of improving the capabilities even though it is for a short period of time.

2.4 Intracranial Self-Stimulation(ICSS) and Deep Brain Stimulation(DBS)

Electrical self-incitement conduct has been considered as one of the strongly compensating social encounters, maybe considerably more ground-breaking than sustaining or sexual prizes. Self – incitement encounter which includes visit commitment of seriously remunerating circuits may result in noteworthy changes in dendritic arborisation of the pyramidal neurons of the limbic and neocortical regions. The specific creatures are fitted with bipolar cathodes in the reward focuses of their brain. DBS is widely utilized for treating Parkinson's Disease. Electrical incitements were directed by experimenter through every terminal day by day with the controlled parameters of flow, recurrence and the postponement between the pulses.

The ICSS showed that the brain can make more connections[11] and can even make new neurons[12,13]. The neurogenesis due to ICSS is a known fact. In this study, we will be having a detailed discussion on ICSS and DBS

3. Recent Developments

Every day, we have been witnessed with new technologies that changed the human style of living. Each day is welcoming us with better ideas that have the potential to "change". Unfortunately, till now there is no considerable breakthrough in the world of intellectually disabled and other neurophysiology areas in connection with cognition. Even though DBS and ICSS giving some hope, till now there is no any major breakthrough

50 years back "Deep Brain Stimulation" was first utilized by Mazars who embedded cathodes in the somatosensory thalamus of patients experiencing deafferentation torment. Later on, more average destinations provoked by Reynolds who distributed the primary proof that electrical incitement of the dark issue encompassing the Sylvain conductor

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could yield sufficient absence of pain to allow stomach activity in rodents. These days for the alleviation of unending obstinate pain coming about because of an assortment of neurotic conditions, Deep Brain Stimulation is an acknowledged clinical procedure. In spite of the expansive number of clinical examinations depicting relief from discomfort by profound cerebrum incitement; a few late surveys of the clinical writing propose that the aftereffects of these systems change impressively among various investigations, that numerous neurosurgeons discover the strategy flighty, that no critical advancement has been made as of late to enhance its viability and dependability, and that extensive difference still exists with respect to issues identified with the method itself[14].

The underlying method utilized for electrical incitement on openly moving rodents were grounded on a turning wire situated over the subject's cage[15]. Amid the time of incitement, the subject had a wire associated over their skull. Be that as it may, this arrangement constrains the quantity of conduct testing to the locale characterized by the length of link; investigation of the remote territory can instigate strains on animal skull where the cathode is entered to the skull.

There are many installed Real-Time frameworks have just been intended for rodents, endeavoring to fulfill recently revealed requirements.

We propose evaluating these arrangements, concentrating on one vital rule: the situation of the circuit in the rat body.

Several examinations have revealed gadgets with embedding an electronic part in the stomach some portion of the subject, associated with a cathode embedded in the brain[16,17]. The huge preferred standpoint is that the rodent can move rapidly after the medical procedure. This decision demonstrates significant hazard factors back to back to a medical procedure, similar to diseases, particularly in the mid-region territory. It is an unquestionable requirement to utilize biocompatible materials. In the above examinations, incitement factors are customized through RF joins; Inter-correspondence is modified utilizing mux, and the RF producer is a cylindrical gadget containing the creature all through the programming of incitement. The subject developments are exceedingly restricted, and DBS activity can't be determined over the span of programming. The battery is kept in the subject body, embedded with the circuit, which required extra medical procedure to modify it, with different diseases conceivable outcomes. This first sort of DBS gadget isn't made to arrange for examinations on rodents since it gives a high danger of reactions for a little term of activity.

The second form of triggers has been portrayed by[18] and[19].The two gadgets are wearable triggers set contributes. It unravels two deformities of embedded frameworks: first, symptoms of medical procedure are characterized as anode addition just, and it isn't vital for the material to be bio-perfect as it was not in contact with tissues. Second, the battery is advantageous on the back of the rat and can be changed for long haul tests.

These trials are constrained from multiple points of view: subject must be put in isolated enclosures; despite the fact that they can detach their vest, and they hazard conceivable outcomes of harming the brain harm when the anodes are hauled out. The utilization of these wearable gadgets is likewise at one point excessively unsafe for long haul experimentation, regardless of whether the two frameworks are considered to regard the electrical standards of tissues wellbeing.

The third kind of triggers is portrayed in[20]. These renditions of triggers are settled to the skull utilizing the dental glue while anodes are embedded into the cerebrum. The danger of contamination is constrained contrasted with the primary class of triggers. In addition, the possibility of breaking the

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gadget is little if its volume and weight are constrained. In this framework, the battery can't be changed on account of the picked stuffing.

These triggers were for one-sided incitements, a setup implied for 6-OHDA-instigated hemiparkinsonism. As neurodegenerative illnesses are respective, we built up a plan which licenses two-sided joining of terminals in the STN of both cerebral halves of the globe. For two-sided incitement, just a single incitement channel is required, yet the most extreme current must be multiplied[21].

In spite of the fact that the adequacy of DBS treatment has been demonstrated clinically, further investigation of the component of brain work control by profound cerebrum incitement is fundamental. In this manner, rodent assessments about on DBS are required. The incitement parameters and the comparing treatment results need to been additionally explored to create a solid and effectively implantable DBS gadget[17].

Most investigations utilize intense incitement in anaesthetized creatures, a couple of gatherings have taken a gander at the impact of long haul incitement in rodents. A designing challenge in such long haul thinks about is a trigger that is little enough to be conveyed by the subject(rodents), adaptable and with adequate consistency to oblige the examination parameters, charge adjusted for security and Power sufficiently effective to animate constantly [22].

We can structure a remote framework in two different ways: one the utilization of explicit coordinated circuits (ASIC), and the other one is business off-the-rack (COTS) parts. Both incorporate their focal points and confinements. ASIC has decreased the size and brought down power utilization[23].Notwithstanding, the expense of planning an ASIC is high, and in this manner, both will in general keep for high volume items. Also, the plan is so explicit in ASIC that they are not adaptable for different applications. Henceforth the surprising expense and the expanded plan time regularly turn into a weight for handy applications. Moreover, these gadgets, for the most part, utilize inductive power exchange as opposed to a customary battery. This result in the advantage of less weight however with a disservice of short remote range. In correlation, remote triggers gathered from COTS modules are in generally speaking either too vast for use with zero sized subjects, or they require more power than what a regular battery can give[16,18–20,24].

With all these studies and reviews, we are introducing a unique and a promising system that gives light into the field of neurological and psychiatric disorders, where the most advanced processor will be the heart of our proposed system

III. MODELLING AND VALIDATION

Based on the data gathered, a model of the cerebrum is proposed here. With a couple of special cases, all correspondence between nerve cells is done along physical associations, frequently connecting cells that are isolated by expansive separations. A flag with these associations comprises of a progression of activity possibilities[25]). Therefore, the power of a brain depends on the number of neurons and the ability of the neurons to make new network of synapses. Some problems though initially not solved becomes solvable after repeated attempts. This implies as the person tries to find out a solution, the ability of the neurons to make connections increases. It is also noted that, as the effort increases, even new neurons are pressed into service[26] to help in solving the task.

Scientific Study. 1 The Neurons Which Fire in Quick Succession Repeatedly, Wire Together

Background

It is postulated that, the neurons that fire together[27]. It was explained in terms of

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strengthening of the synaptic efficacy between two neurons. If two neurons are firing together, then there should already be some wiring between them. A most reasonable wiring pattern between them, in that case, shall be that of a tree structure having a common parent neuron, connected to the two children neurons under consideration. When the parent fires, both the children can be firing together. In that case, an additional connection between the children may not serve any useful purpose.

Many experiences in daily life like learning the name of a person, learning the meaning of a word, learning the relationship between two events as in Pavlov's classical conditioning[28], the case and perfection one acquires after repeated attempts on any task and so on, requires a slightly different understanding of the above wiring together.

Concept

The new concept can be put as follows. The neurons which fire repeatedly in quick successions, wire together. If neurons a and b are firing together. They need not be firing in quick succession because they are already connected directly or indirectly through the parent. Even when having no direct connection between them a pair of neurons a and b can make wiring between them because they are firing in quick succession repeatedly.

Model to Prove the Concept

The Classical conditioning experiment of Pavlov is the best model to prove this concept. It is clear that the dog somehow makes a functional connection between bell and food. Human male such connections between word and its meaning, person and his name and so on. If the two related things are coming at a long gap, the connection does not happen. For example, let a person be presented. The next day, without any reference to the person, a name is said. In such a case none would associate the person and the name together. When these two are given in reasonably close intervals of time, a connection is somehow established between these two. Such connections may be called functional connections. In ICSS, the rat makes a functional connection between pedal pressing and reward.

The parameters of making the connection are repetition, the gravity of the consequence and the time gap between the two stimulation or experiences. If every time a red bulb glows, a cracker as goes off at a distance with a reasonable sound, the just by the force of repetition, an association will be made between the two. A functional and logical connection occurs.

If on the glowing of the red bulb, a terrific cracker explodes very close to one, then the association will take place without much repetition. The next time a red bulb glows, the person is likely to be getting ready for the terrific sound. Yet another example is that of banging onto a low door if a person bangs his head severely against a low door and the head injury. Next time the moment he sees the door, or sees the building, he will be remembering the head injury and so will avoid the disaster. If the bang had been mild, there is a possibility for the person to forget it, and to get another bang too. But when it repeats, the functional connection will be made.

The time gap is also another important factor here. if the two things happen at distant intervals of time, the connection formation is difficult to happen. If the red bulb glows and after 5 minutes the explosion happens, the linking may not happen easily. The best time gap will depend on the person's capabilities.

DrHebb D O proposed that synaptic viability between two neurons is reinforced if the first over and over adds to trigger the second. Taking cognizance of this Andrew has tried to connect two parts of the brain by repeated stimulation [4]. He associated one neuron to another by setting off the second, utilizing the active capability of the first. To make a fake connecting between two spots by

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activity possibilities record on one terminal to initiate the other Andrew utilized neurochip. He builds up that steady reconstruction of motor cortex can be brought by a manufactured connecting between on the two positions in the motor cortex are openly carrying on primates[4]. This means that the firing of neurons in tandem helps to make a connection between them.

Scientific Study. 2 As the Effort Increases, The Reach of Neurons Increases

Background

As the tale of the spider in the history of Robert Bruce goes, some who are unable to do a particular job properly, do so at later stages. The one who could not solve a problem in the initial stages could do it later stage. A problem which was not solvable initially become at least at times, solvable after repeated attempts. A task which was difficult in the beginning become easier in the later stages. These phenomena can be explained by this scientific study.

The muscles get more strength to do better as the exercising increases. Animals get more expertise to do better with an increased number of trials. Then it could be naturally assumed that neurons also become better equipped to make longer connections by repeated attempts.

Concept

As the increase of the neuronal activities, synapses forming increases. what makes the formation of new synapses possible? The neuron acquires an ability to make the connection at farther places, as the effort from the part of the subject increases.

With reiteration, more dendritic procedures come to fruition. ICSS resulted in an extensive development in the numerical centralization of dendritic spines and prickly excrescences [26]. This implies with redundancy in the ICSS, more dendrites and procedures come to fruition as nobody should guarantee an expansion in dendrites with only one day of ICSS. Together with the expansion to dendritic builds, a noteworthy increment as saw in the thickness of various parts of the mind of the ICSS experienced rodents[2]. In the CA3 region, synaptogenesis has happened in light of the fact that the impact of ICSS in the hippocampus and the sub-atomic layer of the motor cortex zones[26]. So with the rehashed ICSS, numbers, neural connections are shaped. More neurotransmitters come to fruition just with more dendritical expanding and there is no reason for these being of a similar length alone. '10 days of ICSS brought about the arrangement of an enduring increment in dendritic stretching and durable increment in dendritic inCA3 hippocampal and layer V engine cortical pyramidal neurons'[2]. This means that with repetition, not only that the new synapses form, but also that those synapses happen at a longer distance. The reach increases with practice or repetitions.

Taking the example of music training, it is found out that when training commences later, brain will reorganize by rewiring neuronal webs, inviting adjacent nerve cells are added up to the essential tasks. These all changes to the result in enlarged cortical signs within existing brain structures. This clearly indicates that the neurons make more connections thereby getting help from the hitherto non contacted neurons[29].

There is also a thickening of several spots of the brain with repetition[27]. Enriched stimulation of a body part is enlarged and its cortical representational zones may alter its topographic order[30]. This should be due to the development of new networks. But in the case of final maturation, the additionally made connections should fade if they are not made use of. Very same way as in any bush, after a while.many got deselected and only the fittest or the used ones survive. Even in the case of children, the neocortex gets thickened in the initial stages up to about 12 years of age and then a thinning down happens[31]. This should be because of the selection

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process set in. Only the frequently used ones stand and others fade.

Model to Prove the Concept

Repetition is a must. It makes better anchoring and bonding with neighbouring neurons. In the context of the study, 'said once and forgotten forever' should not be the model. Recollection of the things studied itself will cause spreading out of better connections between the neurons. A passage read once v/s read multiple times at distributed points in time will make differing outcomes. In latter, it will cause the connections with many of the existing concepts. This should be because newer connections are made and it gives different and deeper meanings.

Many people who could not solve a problem in the first attempt have done so in subsequent attempts. This means that somewhere, a connection which was not getting possible was becoming possible with repeated efforts. The increase in length need not be understood, in terms of physical length alone, but in terms of facilitating a synapse to work in a better way. Some synapses may require more synaptic vesicles to arrive before an action potential there[27]. This sort of sensitization or desensitization also could be thought of as the acquiring of reach by neuron due to practice or repetition.

Application of the Models

Based on the scientific studies that we have been discussed, we have developed a device that is performing according to our required demands. This model can be applied to stitch the brain. The entire process can be called as stitching in time. By manipulating events in time, connections may be brought about in the brain, as the brain has the tendency to wire together the neurons which are firing in quick succession.

To make such a connection a sequence generator or 'Stitcher in time’ can be used. With the require the required stimulations shall be applied to the required parts of the brain. Thus different networks of the brain can be made closer in time. It is called a 'stitch in time' of the brain. Usually, doctors stitch in space, bringing two parts closer in time. Now let’s have the more discussions about the device. Overall DesignThe DBS framework specific for small subjects comprises of circuit modules of the beat generator, a battery, a bipolar coaxial terminal and a software engineer. General view of the framework has appeared in Fig.1.

The generator is a programmable trigger administered by a chip. The gadget is fueled by a small type battery. The electrical pulses delivered activity in the profound brain area of rodents by means of anodes. The software engineer can direct the mode and parameters of the incitement pulses and can get work data from the pulse generator through remote correspondence [17,23].

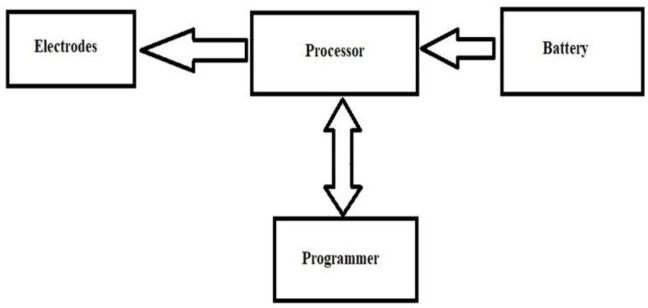

Figure 1: Block diagram of a general stimulator. It shows a general view about their major components and their interconnections

Pulse generator

Pulse Generator mainly consists of an advance microcontroller that can control the whole circuit. It will have equipped with a wireless receiver that enables to transfer data. It can deliver programmable biphasic waves. Feedback system will always ensure that the precise quantity of pulses is delivered. The device can be programmed using wireless communication or by USB connection. Choosing of an advance microcontroller with low

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power dissipation will be helpful for having a long time stimulation

Stimulation Pattern

In the cathodic stage, the activity possibilities are begun by applying a current trigger and the neural reaction is inspired. At that point, the anodic eliminate drops the charges focused on the terminal tip. Normally Anodic stages are postponed extensively to keep the spread of activity potential [33].

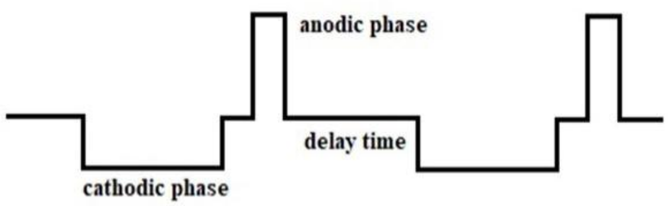

Figure 2:Charge imbalance waveform with interphase delay. It is the safest neural stimulation. It prevents from tissue damage without oxidizing the electrode.

Electrodes

Basically, there are two essential components to charge entrance from a metal cathode into an electrolyte. The underlying charging and releasing includes of the double layer capacitance, causing an improvement of charge in the electrolyte however no in electron transference from the anode to the electrolyte.

The ideal material for use as an invigorating terminal fulfills the accompanying necessities. (1) The unstimulated material must be biocompatible, so it ought not make a poisonous or hypochondriac response in the close-by tissue, nor a superfluous outside body or invulnerable is reaction. (2) The material must be mechanically appropriate for the application. It must keep up mechanical uprightness given the proposed tissue, surgery and length of utilization. In the event that a gadget is to be utilized incessantly, it must be sufficiently adaptable to withstand any little development between the gadget and tissue following implantation. (3) The entire framework must be adequate. This makes sufficient accuse can be included of the favored material and anode territory to cause activity possibilities.

On the off chance that the operational terminal is started to drive cathodically first in a biphasic waveform and in this manner the other(counter) terminal anodically, at that point amid the other stage the working anode is driven anodically and the contrary district anode cathodically. In such a framework the working anode is alluded to as a cathode. In a perfect world talking, the working terminal is the cathode amid the motivating force stage, and amid the inversion stage, the jobs are rearranged with the goal that the working terminal will be anode and along these lines it will continue[34].

Working

The stitcher is a microcontroller based device which will generate charge imbalanced pulses with interphase delay train which in turn could be fed to required parts of the brain, to help their connecting or stitching together. The basic functioning of a stitcher chip can be explained like this. When the subject completes its desired work, automatically the device will be triggering stimulation pulses within a short duration of time in various places of the brain along with the reward point. The sequence continues on other pins. Once the pulse train appears on all other pins one after the other (one round is completed), the same thing repeats for a second round. As many rounds are required or as much time as required, this process can be repeated. Since the chip is programmable amplitude, frequency and delay can be altered. Once these values are set the pins could be connected to the desired point in the brain of the subject.

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IV. PROPOSED SYSTEM

SMART Hall

SMART stands for Self Involved Motivated Action Reward Technique. By combining modified ICSS and giving a suitable environment is envisaged, which will provide enough and more of involvement to the participating subject. This, in turn, will increase the neuronal density of the participants and hence enhance their capabilities. SMART hall is such an arrangement where the model method of rewarding is integrated with traditional methods of recreation available with a suitable environment. Every traditional recreational facility is attached with an intracranial stimulation giving extreme pleasure to the participating subject. As the reward, intracranial stimulation very pleasing, the motivation will be very high, eliciting maximum self-involvement (video description)

Video Still: Animation of proposed system is portrayed here. The system is used in controlled environment, where all the actions are monitored using cameras, RF tags. The subject is under enrichenvironment, where it facilitates to adapt motor skills.

Different modified ICSS facilities will be arranged in a big hall. Subjects can choose their own facilities as they like. As each one goes to the particular facility, the user is identified by the RF-id tag he wears, and the system adjusts the response accordingly. If the user gets attached to a single facility, the system takes the steps to somehow repel that one from that facility. Fig.3 shows the action plan of the proposed system.

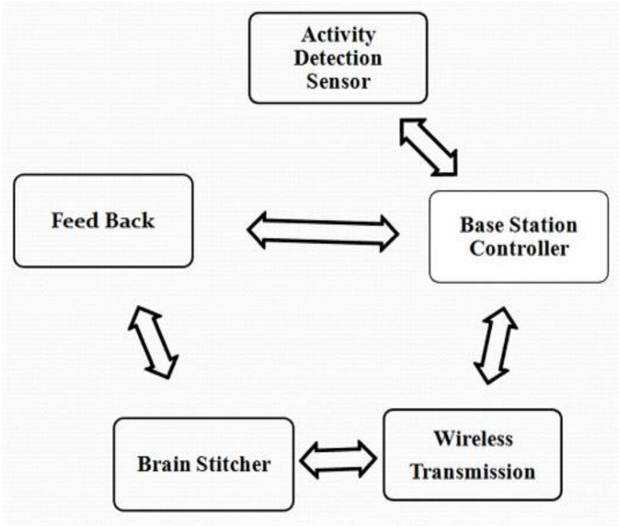

Figure 3: Pictorial representation of the proposed system. Action oriented reward system intended for mentally challenged children to adapt motor skills. The Whole System is based on Enriched Cage Experiment.

Repelling the Subject from the Addiction

As the number of session goes up the no of times action to be repeated for stimulation goes up. Together with that in later stages, the amount of stimulation received also goes down. At a later stage if the same subject comes up for the same facility it gives a cold shoulder to the user. This will help not to develop an addiction to the facility but to vane away, the child from the facility is the due course of time.

The social nature of the facility is very helpful in many ways. There will be interaction and exchange of ideas among the participants. Thus it will not become a machine interactive session. As one does the other can see and learn a lot. One can in many cases, teach the other one. These aspects will increase the communication of learning and will automatically improve the capabilities of the brain.

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Other than small and silly actions like pressing a pedal the traditional recreational facilities in the rich cage are made into activities required to get stimulation in a smart hall. As the traditional activities require more involvement and the stimulation obtained is highly pleasing, both objectives will be met. When the subject completes one oscillation on an ordinary swing, it gets a stimulation. Similarly, when a subject completes a sliding on an inclined plane, it gets stimulation. Later for n repetition of the same activity will get one stimulation. Here n can be range from 1 to 3 or 4. The activity to be done to get a stimulation is changed which is given with some audio or /visual instruction, thus the hunting for pleasure will be intensified and the brain will grow.

Single Person Smart Hall

In the case of a single individual in a hall different entertaining facilities could be set up. The subject shall wear an electronic kit and electrodes are implanted into his brain. As and when the subject does various activities the connected system sends a pulse to the subject kit which it translates to a proper stimulation. The pulse to be sent may be sent by Bluetooth (a wireless transceiver module) as the subject will have to be walking around without constraints

Multiple person SMART halls

If multiple subjects are to be there in the SMART hall simultaneously then there should be proper arrangements to identify each subject interacting with each system of recreation. For this RFID, technique (which includes a small range electronic tag with transceiver antenna and wireless technique support) could be used.

Technical requirements of SMART hall

Thus the SMART hall should be like this. Various conventional recreational facilities should be provided. Arrangements should be there to identify that a particular subject has utilized the facility. Then the systems should be able to identify the status of that particular subject as a fresher on this facility or experienced one. Based on the level the central system instructs the particular facility to send a pulse to the subject which basically is to give a stimulation ranging from 0 to 1 in intensity. Depending on the experience level proper audio /videos instructions should be given out. In the case of saturated subject information like no better out of trying today or any more on this should be given. The intelligence could be built into the central computer or in the individual chip, the subject carriers effortlessly, in an unreachable way to the subject. The chip could be embedded under the skin behind the ears or some other convenient place near the brain. Another subject who is just watching or trying to do a drill should not be getting stimulation, just because a nearby subject did the drill property. The pulse given to 1 subject is useful to that subject only.

The SMART hall proposed provides an environment where the subject will be highly motivated, highly involved, exploring thoroughly, getting appreciation and acknowledgement from peers, learning by seeing the peers performing, taking cues from virus's clues, efficiently learning by feedback, de-addicted, acquiring a social nature and so on. The subject can become smarter faster by using SMART hall

Social Nature of Multiple Person SMART halls

As there are many subjects working in the SMART hall, they can see each other doing and the one who is doing it well can be proud of doing so in front of many. This works like an acknowledgement and appreciation for their performance. When they played for their Institutes and won laurels, it made an impact on them. They felt important, wasted to grow further and so on. Thus the component of social acceptance and appreciation and so on are to be incorporated into efforts to improve the

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capabilities of mentally challenged children. By proposing a SMART hall for multiple people, this thesis is aiming at a very efficient method for the same.

V. COMPARATIVE STUDY

Here we will be seeing different kinds of stimulator that are available in the market depending upon various factors.

Size	Battery	Weight	Life Time	Controlling Parameters
20mm Diameter	3V/200mAh	NA	NA	Current, Pulse width, Delay, Frequency
8mm*30 mm	4.65V	2.1g	10 hours	Current, Pulse width, Delay, Frequency
15mm * 28mm	6V/36mAh	7.4g	7 days	Current, Pulse width, Delay, Frequency
25mm Diameter	3V/280mAh	7.8g	9 days	Fixed
15mm * 22mm	3V/250mAh	5.08g	12 days	Current, Pulse width, Delay, Frequency
33mm * 20mm	3.6V/250mAh	11.5g	10 days	Current, Pulse width, Delay, Frequency
15mm * 18 mm	3V/250mAh	4.75g	22 days	Current, Pulse width, Delay, Frequency

Table 1: Comparison between the systems

VI. DISCUSSIONS AND FUTURE DEVELOPMENT

This futuristic oriented system helps in including the million especially differently abled human around the world into the path of evolution and to help them create for themselves a platform where they can involve in contributing to the development of the society with the help of this chip. This chip helps them in stimulating their brain activities to an extent that is considered desirable in order to boost their performance and be a productive human resource. This will be a promising system that can be considered a cure for various diseases that are close in relation to the brain activity. They included conditions like epilepsy, Parkinson’s disease, chronic pain, Dystonia and even for normal people.

VII. CONCLUSION

Brain Stitcher will make an effort to stimulate the brain and analyses the following aspects

- Number of synapses made
- The effort was taken by the subject to solve the problem
- Formation of shortcuts in the brain
- Length of the path formed in solving the problem
- Winnability of the brain for a set of given problems

Brain stitcher can make the connection between the required networks of the brain. Depending upon the neurologists' recommendation, the proper amount of voltage for the proper amount of time could be applied to a series of location in the brain in a repetitive manner by this brain stitcher, which in turn will wire the required parts of the brain networks.

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REFERENCES

[1] K. Ramkumar, Srikumar, B.S.S. Rao, T.R. Raju: 'self stimulation rewarding experience restores stress induced CA3 dendritic atrophy,spatial memory deficits and alteration in the level of neurotransmitters in the Hippocampus', Neurochemical Research, 2008, 33 (9) pp.1651–1662.

[2] B.S.S. Rao, T. Desiraju, T.R. Raju: 'Neuronal plasticity induced by self-stimulation rewarding experience in rats — a study on alteration in dendritic branching in pyramidal neurons of hippocampus and motor cortex', Brain Research, 1993, 627 (2) pp.216–224.

[3] C.T. Moritz, I.P. Steve, E.E. Fetz: 'Direct Control of paralysed muscles by cortical neurons', Nature, 2008, 456 pp.639–642.

[4] A. Jackson, E.F. Eberhard, J. Mavoori: 'Long Term motor cortex plasticity induced by an electronic neural implant', Nature, 2006, 444 pp.56–60.

[5] U. Tontsch, D.R. Archer, M. Dubois-Dalcq, I.D. Duncan: 'Transplantation of an oligodendrocyte cell line leading to extensive myelination', Proceedings of the National Academy of Sciences, 1994, 91 (24) pp.11616–11620.

[6] C.R. Freed, P.E. Greene, R.E. Breeze, W.-Y. Tsai, W. Dumouchel, R. Kao, S. Dillon, H. Winfield, S. Culver, J.Q. Trojanowski, D. Eidelberg, S. Fahn: 'Transplantation of embryonic dopamine neurons for severe Parkinson's disease', Neuroreport, 2001, 344 (10) 710-719.

[7] Y. Kurimoto, H. Shibuki, Y. Kaneko, M. Ichikawa, T. Kurokawa, M. Takahashi: 'Transplantation of adult rat hippocampus-derived neural stem cells into retina injured by transient ischemia', neuroscience letters, 2001, 306 (1-2) pp.57–60.

[8] V.S. Ramachandran, B. Sandra: 'Phantoms in the Brain, available at www.HarperCollins.com.

[9] L. Knechtel, U. Schall, G. Cooper, S. Ramadan, P. Stanwell, T. Jolly, R. Thienel: 'Transcranial direct current stimulation of prefrontal cortex: An auditory event-related potential and proton magnetic resonance spectroscopy study', Neurology, Psychiatry and Brain Research, 2014, 20 (4) pp.96–101.

[10] A.W. Snyder, E. Mulcahy, J.L. Taylor, D.J. Mitchell, P. Sachdev, S.C. Gandevia: 'Savant-like skills exposed in normal people by suppressing the left fronto-temporal lobe', Journal of Integrative Neuroscience, 2003, 02 (2) pp.149–158.

[11] P.N. Bindu, T. Desiraju: 'Increase of dendritic branching of CA3 neurons of hippocampus and self stimulation areas in subjects experiencing self stimulation of lateral hypothalamus and substantianigra - ventral tegmental area', Brain Research, 1990, 527 (1) pp.171–175.

[12] G. Ming, S. Hongjun: 'Adult Neurogenesis in the Mammalian Central Nervous System', Neuroscience, 2005, 28 pp.223–250.

[13] T. Takahashi, Y. Zhu, T. Hata, C. Shimizu-Okabe, K. Suzuki, D. Nakahara: 'Intracranial Self - Stimulation enhances neurogenesis in hippocampus of adult mice and rats', Neuroscience, 2009, 158 (2) pp.402–411.

[14] G.H. Duncan, M.C. Bushnell, Marchand Serge.: 'Deep Brain Stimulation: a review of basic research and clinical studies', Pain, 1991, 45 pp.49–59.

[15] W.A. Carlezon, E.H. Chartoff: 'Intracranial self-stimulation (ICSS) in rodents to study the neurobiology of motivation', Nature protocols, 2007, 2 (11) pp.2987–2995.

[16] R. de de Haas, R. Struikmans, G. van der Plasse, L. van Kerkhof, J.H. Brakkee, M.J.H. Kas, H.G.M. Westenberg: 'Wireless implantable micro-stimulation device for high frequency bilateral deep brain stimulation in freely moving mice', Journal of neuroscience methods, 2012, 209 (1) pp.113–119.

[17] X. Qian, H. Hao, B. Ma, X. Wen, L. Li (Eds.): 'Study in DBS Device for Small Animals, IEEE, Piscataway, N.J., 2011.

[18] M. Alam, x. Chen, E. Fernandez: 'A low-cost multichannel wireless neural stimulation system for freely roaming animals', Journal of neural engineering, 2013, 10 (6) pp.66010.

[19] G.N. Angotzi, F. Boi, S. Zordan, A. Bonfanti, A. Vato: 'A programmable closed-loop recording and stimulating wireless system for behaving small laboratory animals', Scientific reports, 2015, 4 pp.5963.

[20] R.C. Pinnell, J. Dempster, J. Pratt: 'Miniature wireless recording and stimulation system for rodent behavioural testing, 2015, 12 (6) pp.66015.

[21] F. Kölbl, N.'K. Gilles, N. Frederic, B. Florent, F. Emilie, R. Sylvie, B. Abdelhamid, L. Noelle: 'An Embedded Deep Brain Stimulator for Biphasic Chronic Experiments in Freely Moving Rodents', IEEE Transactions on Biomedical Circuits abd Systems, 2016, 10 (1) pp.72–84.

[22] A.I. Acosta, M.S. Noor, Z.H.T. Kiss, K. Murari (Eds.): 'A Lightweight Discrete Biphasic Current

Stimulator for Rodent Deep Brain Stimulation, IEEE, 2015.
[23] H.-G. Rhew, JeongJachun, J.A. Fredenburg, S. Dodani, P.G. Patil, M.P. Flynn: 'A Fully Self - Contained Logarithmic Closed - Loop Deep Brain Stimulation SoC With Wireless Telemetry and Wireless Power Management', IEEE Journal Of Solid - State Circuits, 2014, 49 (10) pp.2213–2227.
[24] F. Fluri, T. Mützel, M.K. Schuhmann, M. Krstić, H. Endres, J. Volkmann: 'Development of a head-mounted wireless microstimulator for deep brain stimulation in rats', Journal of neuroscience methods, 2017, 291 pp.249–256.
[25] O. Sporns: 'Network Analysis Complexity and Brain Function', Complexity, 2002, 8 (1) pp.56–60.
[26] B.S.S. Rao, T.R. Raju, Meti B. L.: 'Increased Numerical density of synapses in CA3 region of Hippocampus and molecular layer of motor cortex after self - stimulating rewarding experience', Neuroscience, 1999, 91 (2) pp.216–224.
[27] E.R. Kandel, J.H. Schwartz, T.M. Jessel, S.A. Siegelbaum, A.J. Hudspeth (Eds.): 'Principles of neural Science, 4th ed., McGraw - Hill Health Profession Divison, London, 2013.
[28] I. Goormesano, W.F. Prokasy, R.F. Thompson (Eds.): 'Classical Conditioning, 3rd ed., Psychology Press, New Jersey, 2014.
[29] E. Altenmüller: 'Apollo's gift and curse brain plasticity in musicians, in: Music & medicine.
[30] A. Sterr, M.M. Matthias, B.R. Thomas Elbert, P. Christo, T. Edward: 'Perceptual Correlates of Changes in Cortical Representation of Fingers in Blind MultifingerBrailler Readers', The Journal of neuroscience the official journal of the Society for Neuroscience, 1998, 18 (11) pp.4417–4423.
[31] Shaw P., Greenstein D., Lerch J., Clasen L., Lenroor R., Gogtay N., Evans A., Rapoport J., Giedd J.: 'Intellectual Ability and Cortical Development in Children and Adolescents', Nature, 2006, 440 (7084) pp.676–679.
[32] H. Chun, Y. Yang, T. Lehmann (Eds.): 'Required Matching Accuracy of Biphasic Current Pulse in Multi-Channel Current Mode Bipolar Stimulation for Safety, IEEE, Piscataway, NJ, 2012.
[33] S. Moradi, E. Maghsoudloo, Lotfi Reza (Eds.): 'New Charge Balancing Method Based on Imbalanced Biphasic Current Pulses for Functional Electrical Stimulation, IEEE, 2012.
[34] D.R. Merrill, M. Bikson, J.G.R. Jefferys: 'Electrical stimulation of excitable tissue: design of efficacious and safe protocols', Journal of neuroscience methods, 2005, 141 (2) pp.171–198.
[35] H.-Y. Liu, J. Jin, J.-S.Tang, W.-X.Sun, H. Jia, X.-P.Yang, J.-M.Cui, C.-G. Wang: 'Chronic deep brain stimulation in the rat nucleus accumbens and its effect on morphine reinforcement', Addict Biol., 2008, 13 (1) pp.40–46.
[36] C. Forni, O. Mainard, D.G. C. Melon, L. Kerkerian-Le Goff, P. Salin: 'Portable microstimulator for chronic deep brain stimulation in freely moving rat', Journal of neuroscience methods, 2012, 209 pp.50–57.
[37] Y. Wu (Ed.): 'Advances in computer, communication, control and automation: A Head Mountable Deep Brain Stimulation Device for Laboratory Animals, Springer, Berlin, 2011.
[38] A.Z. Kouzani, O.A. Abulseoud, S.J. Tye, M.D.K. Hosain, M. Berk: 'A Low Power Micro Deep Brain Stimulation Device for Murine Preclinical Research', IEEE Journal of Translational Engineering in Health and Medicine, 2013, 2 pp.1500109.
[39] S.G. Ewing, B. Porr, J. Riddell, C. Winter, A.A. Grace: 'SaBer DBS: A fully programmable, rechargeable, bilateral, charge-balanced preclinical microstimulator for long-term neural stimulation', Journal of neuroscience methods, 2013, 213 pp.228–235.
[40] A.Z. Kouzani, R.P. Kale, P.P. Zarate-Garza, M. Berk, K. Walder, S.J. Tye: 'Validation of a Portable Low-Power Deep Brain Stimulation Device Through Anxiolytic Effects in a Laboratory Rat Model', IEEE transactions on neural systems and rehabilitation engineering a publication of the IEEE Engineering in Medicine and Biology Society, 2017, 25 (9) pp.1365–1374.