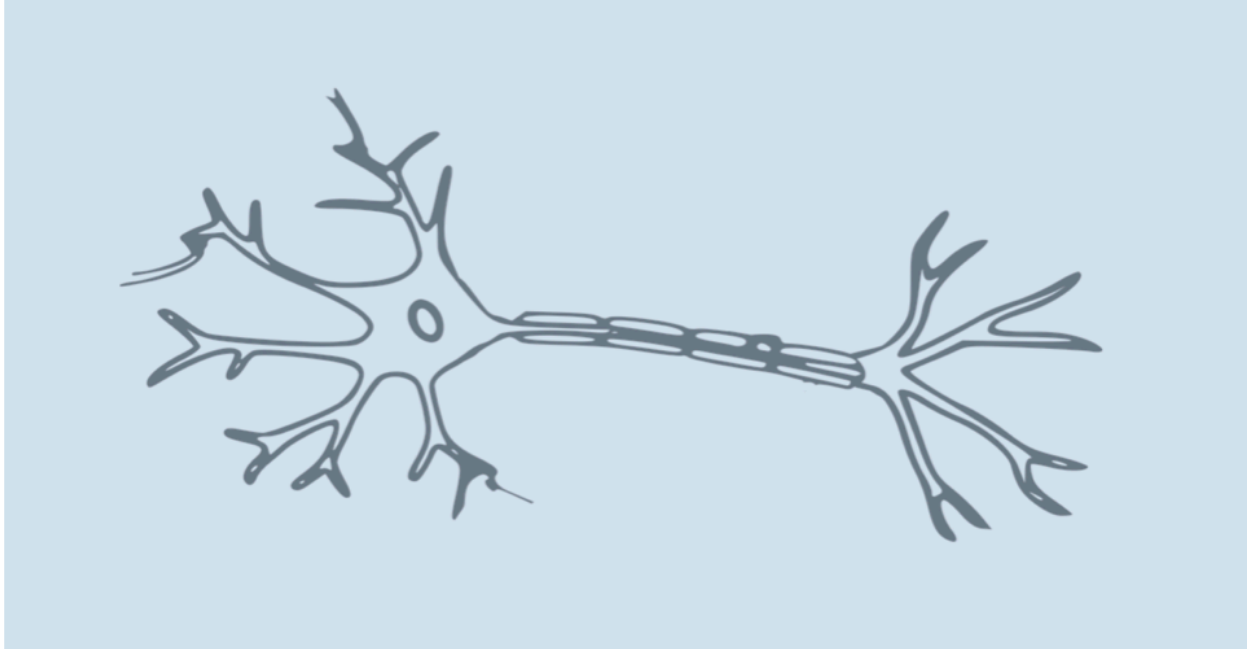


Long Term Potentiation And The Growth Mindset



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General Background on the topic

In writing this paper I set out to understand a little bit more about the power of the mind and the changes that could potentially be possible. When I was a kid I remember first learning about the spinal cord and the possibility of a disconnect in the “communication lines” so to speak, when a childhood hero of mine, literally Superman or the actor who played him was paralyzed by an accident while horseback riding. Christopher Reeves, was now in a wheelchair after being able to leap tall buildings in a single bound. I remember hearing a lot of information about how he wanted to put research into trying to overcome being paralyzed. I didn't know at the time that people who are paralyzed often have a substantial decrease in their lifespan. Christopher Reeves died before he could see the fruits of his work materialized. It was not until after his death that leaps and bounds were made and other people were able to benefit from the fruits of his labors. Ultimately Scientists were able to come up with a way to place an electrical stimulator near a group of neurons in a part of the spine called a central pattern generator. These neurons are responsible for moving the hips, knees, ankles, and the toes and don't need to involve the brain. Flash forward to the present time. I have been teaching Yoga Pilates and Fitness Training for over 24 years and a huge topic in the wellness world is mindfulness and “Mindset”. This is a common buzz word especially in the business side of health and wellness, and one could ask, “What exactly is mindset, and can we really change it for the better?” How are advances in recovery from spinal injury and the growth mindset related? They are related through the concept of Long Term Potentiation and its relation to learning and memory. In the same way we can strengthen our neural pathways in the physical body, we can strengthen our neural pathways that relate to how we think and feel and essentially “Change our minds”, hopefully for the better.

What Is Long Term Potentiation?

First it will be important to have some background information on what Long Term Potentiation is. Wikipedia defines it as “a persistent strengthening of synapses based on recent patterns of activity.” I was so surprised in our class lecture on learning and memory to hear that it is important to be able to forget as well as remember things. I had never heard this before, but it really makes sense if you think of it like the memory we use on our computers. I myself have had many a time when my hard drive was “too Full” and there just wasn’t enough space to take on any new information. A beneficial way we can think of this is, as a home organizer friend of mine once put it, “We can be the curator of our best stuff.” And that really means we just keep what we need and use. In our homes, on our computers and in our own minds. Long Term Potentiation comes into play with regard to the stronger connection to the things we use the most. To use the clearing out analogy, I have a favorite sweater that I am very attached to. Whereas I have a few that are too small or I just don’t like so I am not so attached to those. I can clear those ones out my closet and be able to get to my favorite sweater easier when I clear away the things I no longer use. I also have an emotional attachment to my favorite sweater that communicates to me over and over again that it keeps me warm in more than just the utilitarian sense but in the emotional attachment I have because I have used it and keep using it to serve my purposes on a regular basis. I have and create memories that involve the sweater as well so that strengthens my connection to the importance of this particular sweater. Each memory is another connection to it that communicates to me warmth in the “warm fuzzy” way and nostalgia. “I remember wearing this sweater for my senior portraits and it was a gift from a dear friend” those connections communicate to me This sweater is valuable and I love it and use it and am no way going to get rid of it any time soon. Things we need and use on a regular basis we grow stronger connections with. In the nerve cells, the pre synaptic and postsynaptic cells can literally grow more connectivity and structures to communicate there can be growth and/or

reconstruction of dendritic spines and postsynaptic density can grow making the communication highway faster and more efficient.

How was LTP discovered

LTP was first discovered by Terej Lomo in 1966. The interest in LTP has shown rapid increase as shown by the publication count for articles starting in the 1980's. Over the last 5-6 years, the annual publication count exceeds 700 which is an average of almost two articles published every day of the year. (Dringenberg 2020) The idea that there could be brain plasticity in adults was controversial but in the mid 1960s there was evidence that there were changes in the brain weight and thickness and neurochemical markers induced by the living conditions of rats. The interesting thing was that this was for both young and aged animals (Dringenberg 2020)

This was amazing information because it meant that there was now evidence of possibility for change in the brain of mature adults. This change in the weight of the brain of the mammal that was experimented on, the rat showed hope for older adults and learning and memory. We know that if change occurs in the rat we have the same physiological elements and so that will show that there is a change possible to humans as well. Before this point, the plasticity and potential for learning was thought to only be available for young and developing mammals. As a parent of teenagers I can say that I am grateful that I, an older adult, still have the chance to learn and grow and hopefully keep up with the information that they are learning especially in this day and age and the environment of the "Hard Pivot" into the technological digital age.

What led to the discovery of the Long Term Potentiation

The larger application of the discovery of Long Term Potentiation happened piecemeal. Once it was first discovered in the exploration of the rats brain size differences by Terej Lomo in 1966, it took awhile for the popularity of the topic evolve and then explode

into much more observation and implementation across multiple platforms. The empirical evidence that was gathered across a time span of about four decades lets us know that Long Term Potentiation is one of the mechanisms that allows for memory and learning. The storage of memory happens in the neuronal circuits as we create stronger pathways and communication highways through use. The good news is that the information can also help in the areas of cognitive behavioral neuroscience as well. This allows for the possibility of exploration by neuroscientists into the relationship between the brain and psychological states of being. (Drigenberg 2020)

What role does Long Term Potentiation play in learning and memory

With Long term Potentiation there is a strengthening of synapses, which makes communication between neurons more likely. LTP is thought to be a crucial mechanism involved in memory formation. The thought that experience could lead to synaptic change is a founding mechanism of learning and memory retention has gained a lot of popularity in neuroscience and psychology. This idea is now described as the synaptic plasticity and memory hypothesis. Data was taken from manipulation of visual experience environment enrichments and learning related changes at the synapses of mammals. This experiment showed us a link between synaptic change and memory storage and the idea of synaptic plasticity got really popular when we could see electro physiological recordings that showed activity dependent long lasting changes in the synapses. These included long-term potentiation (LTP) and long-term depression (LTD) and changes were seen in both pre-and postsynaptic elements (Abraham, Jones, et al2019)

How is this all related to the growth mindset?

We can think of the relation of Long Term Potentiation with regard to growth mindset in two ways, 1, rehabilitation, or 2, improvement, where there was not a negative diagnosis to begin with. In the article, Role of Yoga and Meditation in the Context of Dysfunctional Self:

A Hypothetico-Integrative Approach, The authors write about how the role of mindfulness-based training that includes focusing attention, creating a state of relaxation and developing mindfulness by monitoring reactions to the senses cultivating “bare attention” (awareness without thought) the relaxation response as a tool to calm the mind and disconnect from old patterns though awareness with the goal of creating a better adjusted resilient self. These processes were used within the context of changing negative thought patterns in effort to better oneself and heal from destructive thought patterns. (Singh Goel et al 2014)

On the YouTube MEDspiration Podcast, the host Dr. Nav Badesha interviews Stanford Neuroscientist, Andrew Huberman, Ph.D. in the episode entitled “Rewire your Brain for Higher Performance” In it they talk about “Self directed adaptive plasticity” and the possibility to improve one’s own mental outlook and therefore improving their outcomes and experiences.

What are the future directions of Long Term Potentiation

The future direction of long term potentiation now that we have the knowledge of what happens on a molecular level is to potentially use this information to work with healing illness for example working with Alzheimer’s disease. With a better understanding of the pathway of the neural circuits and how they work we can gain new insights into pathology of diseases that deal with a synapse. Not only does this include Alzheimer’s but also mental retardation due to drug addiction. (Malenka and Bear 2020) Many modern LTP studies seek to better understand its basic biology, while others aim to draw a causal link between LTP and behavioral learning. Still others try to develop methods, pharmacologic or otherwise, of enhancing LTP to improve learning and memory. Furthermore, the link to neural plasticity and the “Change Your Mindset” Mentality can have a great effect on many people’s life experiences as they embark on new endeavors and can know for a fact that it is possible to restructure the mental pathways. In Yoga the idea of what is called “Samskaras” is a concept that has been around for ages. The way Samskaras are described is like a groove on a record or a pathway that has been walked over and over again. It is with repetition that we create

these habit patterns that once established are hard to veer away from because we have ingrained them in our memories so strongly. If we are aware and make conscious choices as to which habit patterns we strengthen through repetition, we can then have some effect on choosing habits that serve us and our well being best. The scientific connection will allow the ancient wisdom to connect with the present day and hopefully allow people to be inspired by the fact that we have the possibility to learn more about the way our own brain shapes our experiences and if our experience is framed in a way that does not serve us as human beings, we can, with our awareness begin to make conscious changes for the better.

Resources:

Role of Yoga and Meditation in the Context of Dysfunctional Self: A Hypothetico-Integrative Approach Yogesh Singh, MD; Arun Goel, MD; Rajesh Kathrotia, MD; Prashant M. Patil, MD 2014

LTP and LTD: Review An Embarrassment of Riches
Robert C. Malenka^{1,*} and Mark F. Bear²

The history of long-term potentiation as a memory mechanism: Controversies, confirmation, and some lessons to remember
Hans C. Dringenberg 2020

Is plasticity of synapses the mechanism of long-term memory storage? Wickliffe C. Abraham, Owen D. Jones & David L. Glanzman 2019

MEDspiration Podcast interview with on You Tube host Dr. Nav Badesha interviews Stanford Neuroscientist, Andrew Huberman, Ph.D.
<https://www.youtube.com/watch?v=qJl7lDE77MM>

<https://www.everydayhealth.com/news/standing-up-paralysis-christopher-reeves-dre-finally-comes-true>

<https://www.neuroscientificallychallenged.com/glossary/long-term-potentiation-ltp>

<https://www.webmd.com/men/features/christopher-reeves-legacy-of-research#1>

<https://www.khanacademy.org/test-prep/mcat/behavior/learning-slug/v/long-term-potentiation-and-synaptic-plasticity>