

Risk of Memory Erasers to Reduce Effects of PTSD

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## Risk Analysis of Memory Erasers to Reduce Effects of PTSD

### **Introduction**

The effects of Post-Traumatic Stress Disorder (PTSD) are detrimental for one in eleven people (Miller, et al.,2018). It is not a phase, not something you can get over easily, it becomes a chemical imbalance in your brain. PTSD changes brain activity: it makes certain areas of the brain more active due to stress people are experiencing (Buhmann, & Andersen 2017). These stressful feelings contribute to the biological abnormalities such as memory triggering and emotional response as well as normal human brain function (Abdallah, et al. 2019). When analyzing a patient with PTSD, symptoms are usually negative thoughts and feelings, numbness or feeling detached, trouble sleeping, reliving an incident, avoiding a specific event or even anxiety and depression (NIMH,2017). Those diagnosed with PTSD do not want to fear, they do not want to be downhearted, they do not want to remember the dark times they have gone through, they do not want the heaviness of the memory, but that is what usually happens on a daily basis. Something, as simple as a word, person or place may be mentioned and will trigger an intense physical response within the brain that may affect the whole body. A person may experience trembling, shaking or even a full-blown panic attack in addition to the powerful response that is already happening within their brain (Abdallah, et al.,2019).

Half of all adults in the United States will experience at least one traumatic event in their lifetime, the research in helping find therapeutic treatments for trauma is ongoing (NMIH, 2017). In recent years, treatments have allowed persons diagnosed with PTSD to forget the trauma by blocking or reversing functions in the effected portion of the brain, have begun to be developed (Glannon, 2006). Several treatments have been tested but since they are relatively new and upcoming, there are mixed results. Some treatments seem to be advancing, such as using a

receptor blocker to help reduce the severity of memories called  $\beta$ -noradrenergic. This treatment was tested only on mice. The drug will dully block the release of ions and action potentials which will then attempt to block memories from resurfacing (eVillian, et al., 2016). Other advances include oscillatory entrainment and vagal nerve simulation, the goal of both treatments is to change the brain simulation in order to forget the memory by either decreasing brain wave activity during treatment or stopping synaptic activity (Bremner, et al., 2020 & Hanslmayr, Axmacher & Inman 2019). Although these types of treatments seem promising, helping those with PTSD erase their memories, there is not research on the long-term effects and the success rate to deem them safe and overall successful (Glannon, 2006). There is a possibility of over forgetting and loss of other normal neurological function of emotions. The benefits of brain erasers on patients who have severe PTSD will be worth the potential risk of use, but for now more studies need to be done before it is seen as a regularly suggested treatment.

### **Post Traumatic Stress Disorder**

PTSD also known as Post Traumatic Stress Disorder is a condition that effects many people at different levels. It causes a chemical imbalance within the brain that impacts many other functions within the body including mood, thoughts, actions and much more. PTSD can affect daily life in many ways. In recurrent sensory-memory episodes, the body experiences stress in those moments which can result in symptoms during the episode and lingering results post-treatment. Again, the symptoms can come and go, they can be mild to severe, they can be manageable or a chronic condition, the effects of PTSD are diverse and unique to every person (Miller, et al., 2018). But diversity in symptoms and severity can happen within one patient. Regardless of these effects at different ranges, the brain is undergoing stress, minorly or majorly. This stress can be tied to oxidative stress (OXS) and inflammation (INF) which can accelerate

cellular aging and neuroprogression, compromising patients' immune systems. In other words, the neural activity is being altered due to the mental illness (Miller, et al., 2018). Although OXS and INF are mostly seen within chronic patients, PTSD is a chronic condition for one third of the 11% who have the disorder (Miller, et al., 2018). When PTSD is chronic, the flow of oxygen to the brain is decreased, it may lead to several detrimental effects. The brain requires oxygen to function, if the brain is working overtime to function with low levels of oxygen, it will prioritize the current need and may lead to apoptosis of the cell, or cell death. Brain cells need oxygen to function and if it has depleted its supply to perform its job and since it will no longer function correctly it will self-destruct. OXS also has a link to blood-brain barrier disruptions. These disruptions can negatively impact neural growth and regular brain function. INF affects the brain similarly to OXS, as it is used in immune defense when a cell is in the presence of an antigen (Miller, et al., 2018).

Stress causes an imbalance of oxygen and several other factors on a molecular level. Two experiments were conducted to compare levels of blood antioxidant to determine if levels were different in patients with PTSD and those without the condition. One was done with patients who experienced trauma due to an earthquake. Two enzymes, serum lipid peroxidation and depleted antioxidant enzymes were studied to see if there was a difference, and in fact there was a variation. There was another experiment performed with another type of catastrophic event, this being the Croatian war. Two different antioxidants of superoxide dismutase and glutathione transferase levels were analyzed and again there was a difference between the control and the affected (Miller, et al., 2018). As stated in a research article, "Transcripts for the pro-inflammatory cytokines genes Interleukin (IL)-16 and -18 were downregulated as well suggesting that the patients were immunocompromised" (Miller, et al., 2018). Overall, PTSD

effects can be more than just a reoccurring bad memory, it can affect someone in many more ways than expected. It can lead to accelerate cellular aging and neuroprogression. Having a compromised immune system can eventually lead to early onset of several other medical conditions, such as cardiometabolic disease, neurocognitive disorders, and dementia. These issues are caused by the stress the body experiences when someone has chronic PTSD (Miller, et al., 2018).

Not only can PTSD effect your life tragically, pathologically speaking, in the long run the imbalance within the brain can cause problems with its normal function. Elevated stress levels cause an overall imbalance to the body. The stress response and imbalance cause a synaptic dysconnectivity. This means, again on cellular level, that things are simply not working properly. The cells are not getting the number of ions and other molecules they need to suitably work and function, this can disrupt a large quantity of functions and mechanisms within the brain especially mood (Abdallah, et al., 2019). The article written by Abdallah (2019) claims

....particularly, prolonged stress response maintains a paradoxical increase in extracellular glutamate despite a considerable reduction in glutamate neurotransmission, N-methyl-D-aspartate receptors (NMDARs), and  $\alpha$ -amino-3-hydroxy-5-methyl-4-isoxazlopropionic acid receptors (AMPA) (19; 32; 33). These molecular changes precipitate neuronal atrophy consistent with reduced dendritic length and arborization, and reduction in synaptic density and neurotransmission strength. (Abdallah, et al., 2019).

NMDA and AMPA receptors oversee the flow of certain ions such as calcium, sodium, and neurotransmitters in and out of a cell. If stress levels are elevated for long periods of time, this can alter glutamate amounts around the cell which can then lead a decrease in cell strength.

Basically, with all these processes happening molecularly, the synapse strength decreases along with its connectivity which will lead to alteration in amounts of ion and neurotransmitters (which affect mood and behavior), that have the ability to effect anxiety dysregulation, rapid-acting antidepressants and other behavioral and mood abnormalities (Abdallah, et al., 2019). PTSD can affect the daily life of someone dramatically in this way, it acts on cell function and influences a person's mood and behavior in a negative way possibly causing depression and anxiety.

As stated, PTSD may have a terrible, lasting effect on those who are diagnosed with the disorder. It is important to help find treatments for this disorder even if the neurobiology of PTSD is not fully and completely understood. PTSD can be directly correlated to cases of anxiety, depression, dementia and much more. As previously discussed, when someone has PTSD it can result in so much more than the basic triggered episode. When someone is recovering from PTSD or has never experienced the disorder, and has a 'normal' brain, they live a much different life. In the recovering patient, there is less inflammation in the brain but overall, there is less stress seen within the patient. Although they might continue to be triggered somewhat from the emotion in which is brought on by the initial event itself, the reaction is lessened. The obvious goal of treatment is to have normal function in the brain, and with PTSD this does not occur. The object of treatment is to have a brain function as if the memory did not exist. When a person does not have PTSD, their brain acts as instructed by the body. Where competing systems can alter between internal processing and goal-directed behavior; getting out of bed and sleeping normally is a routine; regular moods and habits are established (Herringa, 2017). When someone has 'recovered' from this disorder, they find the meaning of life again, as they might have had before they developed PTSD. They can experience happiness and positive cognitive effects along with other progressive notions (University of Utah, 2019). That is why it

is crucially important to find a treatment in which the memories can be not only suppressed and lessened but where someone can live a better life filled with reason, happiness and the closest thing to a normal sleep schedule as possible by having the traumatic memory be gone completely.

### **Types of Brain Erasers for PTSD**

In recent years, there have been trials of different medications and treatments for PTSD, but so far nothing has completely dissociated the memories and emotions associated with the disorder until recently when the treatment of brain erasers was developed, analyzed and researched. Brain erasers are a new and upcoming treatment for those with PTSD. Brain erasers alter certain brain functions causing a person to forget a memory or lessen the emotion associated with it to help forget the pain of the event or memory (Lavazza, 2018). This treatment uses things such as receptor blocks on the membranes of the neurons and decreasing or alternating nerve simulation to help forget or change memories.

#### *Receptor Blocker $\beta$ -noradrenergic and the Drug propranolol*

There are several types of potential brain erasers, one of the most researched is the use of the receptor blocker  $\beta$ -noradrenergic and the drug propranolol. This drug effects the release of adrenaline by blocking the effects of the hormone norepinephrine. If norepinephrine is blocked, the levels of adrenaline cannot rise in response to an event or memory (Glannon, 2006).

Although it has not yet been used on humans, it has been a receptor treatment used on mice. This experiment tested over 300 male mice as they were put through several tasks and tests to ensure they were conditioned and did indeed go through a traumatic event to qualify as a 'patient of

PTSD', they were then injected with DL-Propranolol (which is an antagonist of the  $\beta$ -*noradrenergic* receptors that cross the blood-brain barrier) or NaCl as a control at appropriate times (eVillain, et al., 2016). Propranolol would hopefully separate the emotion from the memory of those events in the involuntary brain by not allowing the memory form (Glannon, 2006). This means that the emotion associated to the memory would not be embedded within the brain since adrenaline levels were not elevated. Even more so if the propranolol were administered soon after the event, the lack of adrenaline could prevent the memory from fully forming in the first place (Glannon, 2006).

Eventually, there was a memory test given when the drug was fully out of the mice's system so the researchers could determine if the memory was lost, and it was not due to the drug being present. So, if it worked it meant the effects of the drugs were still present, which would be that the receptor was still blocked. In all, the receptor blocker will dully block the release of ions and an action potential will not hit the threshold; this will supposedly block the memories from being recalled because the neurons are not able to fire and transfer messages (eVillain,et al., 2016).

These tests and tasks were directed to determine if the use of propranolol and  $\beta$ -*noradrenergic* for memory consolidation and reconsolidation would cause specifically memory loss. In this treatment, propranolol, when injected was seen to lessen the emotion within the memory instead of fully "erasing" the memory (eVillain,et al., 2016). Although this receptor blocker may not block the memory completely, the injected propranolol would not be a treatment to block or erase the memory but instead erase the emotions and stress in which is triggered when this event is remembered. It would more so make the memory a 'normal one' as someone could recall the event and not be triggered, they would address it and move on.

### *Brain Oscillations*

Another possible brain eraser treatment is the use of brain oscillation. Brain oscillations through entrainment are seen to be important in processing memories. This treatment has also been a front runner with PTSD brain eraser treatment. It was discovered there is a connection between brain oscillations and memory. Studies have shown that frequency-specific entrainment can alter memory function which can help in changing the memories in patients with PTSD (Hanslmayr, et al., 2019). These types of treatments use stimulation to try to forget the memory by either decreasing brain wave activity during treatment or stopping synaptic activity. This will increase, enable, or decrease the firing of neurons within the brain. To block the memory, synaptic activity needs to be stopped. This is done by the stimulation pattern of neural firing which can be known as brainwave synchronization. Specifically, modulations of oscillation can be done by entrainment (Hanslmayr, et al., 2019). Entrainment can be defined as

....the process whereby two interacting oscillating systems, which have different periods when they function independently, assume a common period” and more closely, “in neuroscience, the two oscillating systems are (i) a rhythmic stimulator (i.e., flickering stimulus, electrical pulses, current sine wave, etc.) and (ii) the stimulated neural population. (Hanslmayr, et al., 2019).

Oscillations via entrainment would change the current oscillations in hope to alter the memories – working and episodic memories.

Several tests with entrainment were reviewed and analyzed within Hasnylmar’s (2019) article. There was an abundance of different entrainment tests such as noninvasive electrical (tES), electro-magnetic (rTMS), deep brain stimulation (DBS), and sensory entrainment both invasive and noninvasive nature. The invasive tests were seen to interrupt specific brain target areas

better. When compared to the invasive treatment, the noninvasive seemed to disrupt more inside multiple memory related systems (Hanslmayr, et al., 2019). This information can be used then to determine in which ways the associated trigger memory should be altered—specific target, in a general sense or both. The article concludes that brain oscillation executes some functions in the brain that help in memory mechanisms such as forming and recalling those memories but also in linking and preserving them (Hanslmayr, et al., 2019). There seems to be promising results in memory alterations within invasive and noninvasive entrainment even with possibly very different outcomes between them. Entrainment can alter memories, they can ‘erase’ brain waves. Again, this frequency specific entertainment treatment can alter memory function which can help in changing the memories within patients with PTSD.

#### *Non-Invasive Cervical Vagal Nerve Stimulation*

More specifically one oscillatory entrainment, a treatment done with non-invasive cervical vagal nerve stimulation (nVNS) has recently seen success. This treatment erases memories by reducing stress sympathetic reactivity by changing neural responses from specific, personalized traumatic scripts (Bremner, et al., 2020). An experiment lead by Douglas Bremner (2020) showed the advances within this treatment. It consisted of nineteen participants who had experienced trauma and went through three sequential time blocks where personalized traumatic scripts were presented to them and then immediately after shown the script, they experienced sham simulation as a control or active nVNS. High Resolution Positron Emission Tomography (HR-PET) was used to analyze the brain blood flow activity with radiolabeled water (Bremner, et al., 2020). The results were as following

...greater activation was observed during sham stimulation compared to nVNS within the bilateral prefrontal and orbitofrontal cortex, premotor cortex, temporal lobe,

parahippocampal gyrus, insula, and left anterior cingulate. During the first exposure to the trauma scripts, greater activations were found in the motor cortices and ventral visual stream whereas prefrontal cortex and anterior cingulate activations were more predominant with later script presentations for those subjects receiving sham stimulation. (Bremner, et al., 2020).

The results indicated that there was a stronger activation within the control sham stimulation than with nVNS. The neural reactivity when showed a trigger picture should stimulate activity like in the control but since there was a decrease in reactivity within regions such as the limbic, it shifted from triggering emotions to processing emotions after the emotional stressor was presented in all three exposures (Bremner, et al., 2020). Overall, it decreased activity for both scene reconstruction and subsequent adverse emotional responses. It helped in forgetting or changing some memories and helped decrease the emotional attachment of the event so it can be remembered as an event and not a traumatic event (Bremner, et al., 2020).

### **Advantages and Disadvantages of Brain Erasers**

#### *Benefit of Using Brain Erasers*

The benefit of using brain erasers for patients with post traumatic stress disorder is as simple as helping them live a normal life. Although the treatment of brain erasers is an appealing idea, it is still very new, and the advances have not been fully researched and may not be safe enough to trust. Because the treatment has not been available very long, the long term and all potential side effects have not been identified.

#### *Risk of Using Brain Erasers*

Because the use of brain erasers to treat PTSD is newly developed, all the side effects have not been yet discovered. The studies are so new that there is a possibility a patient may lose more memories than intended. It could possibly make a person with PTSD lose oneself instead of getting who they were back. In Andrea Lavazza's article she states, "the chemical alteration of one's memory might lead to non-authentic choice..... the modification of part of her autobiographical memory, especially the emotional salience of some events, has made it so that the latter lost the motivating power they had before" (Lavazza, 2018). In this she is referring to a specific example, where a girl who did something wrong due to the fact her autobiographical memory is not functioning as needed. Her emotion within the memory was lessened but now so has her emotions overall, as she is forgetting more of who she is such as her morals, events before, etc. She did not just forget the event that triggered her PTSD, but she is forgetting her identity (Lavazza, 2018).

It is possible that this is seen as self-betrayal in the sense a person is not going to follow their 'core'. They could possibly go against how they would normally respond because there is no pain, which is very good, but they might continue to detach from reality and themselves as they are forgetting the memories that make up who they indeed are. Memories are part of what makes us human, they are the stories, the conditioning, the intelligence, they are everything. They are survival and identity (Glannon, 2006). If you delete one, and there is a chance there can be deletion of more memories, and it could harm more than it helps it could ruin more (Lavazza, 2018). As with the noninvasive entrainment, it covers disruptions in more portions of the brain and effects more areas on multiple memory related systems and not just the one specific area (Hanslmayr, et al., 2019). If it effects more areas, it has the opportunity to hurt more areas and result in the negative side effects discussed.

As previously stated, brain erasers are not deemed completely safe. Given the limited information there is not a complete understanding of the complex neurophysiological effects of entrainment or not enough translational research on the characteristics of  $\beta$ -noradrenergic receptors effects on memory (eVillian, et al., 2016 and Hanslmayr, et al., 2019). Propranolol is the drug used within the  $\beta$ -noradrenergic receptors treatment. The effects of this erasure drug are not yet discovered, and it could damage other associated systems. This could potentially unfavorably affect a person's able to learn and to do new and different things which makes the side effects of the treatment also ethically significant (Glannon, 2006). If someone is diagnosed with PTSD at a young age, this could possibly interrupt a young person's ability to learn things such as reading or math. They might not be able to remember the details on how to drive a car or have specific muscle memory. Even if someone is older, learning people's names or a new task could hypothetically be impossible. There is so much uncertainty within this field the unknowns are unlimited.

Brain erasers can cause problems within the memories and losing oneself but also could cause other neurological problems since you are altering the normal neurological functions of the brain. This normal neurological function is the emotion of fear. Although the whole point of brain erasers is to indeed erase the memory or erase the fear associated with it, if fear is completely taken out of the picture that can result in various other problems. As discussed, adrenaline plays a huge role within developing these trigger memories and other memories. Adrenaline can be apart of normal scary events, or even amazing events. They can be thrilling, loving, embarrassing, scary—they can be anything but when they happen adrenaline is released and helps embed the memory within the brain (Glannon, 2006). If the adrenaline is not being released those memories are not only not being formed but the emotion associated is not

becoming present within the person. This treatment has not come close to being fully developed and since “off label and other novel uses of psychotropic and other drugs” are to be used within the nervous system to supposedly change specific memory function, it is just unsafe to use at the present time. There are simply too many unknown side effects of this treatment (Glannon, 2006). These treatments are all so new, researchers do not know if it could just decrease fear within that specific memory, or it could possibly reduce fear and other memories all together. If someone does not have a natural fear response they can get into dangerous or deadly situations as they can be vulnerable to real threats (Glannon, 2006).

The unknowns of this type of treatment are currently endless, most rely on the fact that they need more research and also are not deemed safe as they do not have all the side effects discovered as it is mostly still experimental. The cost of the brain erasers can be very detrimental, there are less harmful treatments such as regular one-on-one therapy, antidepressants, and music therapy, all have been successful treating patients with PTSD. Besides ‘regular’ therapy, music therapy have been the most wholistic and organic way of helping patients desensitize their memories (Buhmann & Andersen, 2017). Music therapy analysis has found that it affects the arousal regulation and emotional processing within a person. It has been seen to provide a safe attachment style, with its insertion of not only music but imagery it has lessened some of the emotion included with the trigger memory (Beck, et al.,2018). The article reiterates that two methods of the music therapy method, Trauma-focused Music and Imagery (TMI), have an overall positive result. In an experiment, both of these methods were done with refugees, and the statement of positive results deemed true. The results showed that these patients who indeed went through severe trauma saw substantial differences within their life. These differences included improvement in quality of life, sleep and previous

symptoms after this therapy was completed (Beck, 2018). It has been seen to not only lessen the emotion but also help the overall person in other ways of getting back to normal life. Not only with music therapy, but other treatments such as therapy and medication are seen to be a safer and more studied avenue of PTSD treatment.

### **Concluding Remarks**

Researchers are working to continue the studies and experiments to improve the lives of patients suffering from PTSD. The discussion in whether the use of brain erasers to treat this disorder are worth the potential risk is still being investigated. Even with the advances, this as a collective whole, needs more time and more studies to be done before it can be viewed as a commonly suggested treatment for PTSD. Based on these studies and finding discussed, currently there is still a risk a of memory loss, loss of fear response and an abundance of unknown long term side effects that make this treatment overall unsuitable and unsafe at this time. Currently, there are no recommendations to reduce the risk of using brain erasers. This will not be seen until scientist find a treatment with pharmacology that can be authorized at low risk of dangerous side effects. The next step in possibly finding a safer treatment will be with continued research. More information, more time, and more trails need to be completed, especially within the propranolol experiment since that seems to be the most successful thus far (Lavazza, 2018). If more is done, the greater chance this type of treatment has an opportunity to grow into to something that can be successful.

The advances in medicine and pharmacology for PTSD are continuing every day. The use of brain erasers is a new and upcoming treatment that is already seeing positive results and feedback. Although, several types are working for some, this type of treatment in general has not been around long enough to be classified as a safe and suitable treatment for those with PTSD.

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