

# Understanding PTSD: Impacts on Memory, Brain Structure, and the Formation of False Memories

By Kushal Madhabhaktula

## Author Biography

Kushal is a freshman at an American high school interested in psychology and neuroscience. Passionate about understanding the intricacies of the brain and human behavior, Kushal actively pursues knowledge in these areas through extensive reading and research. Outside of academics, Kushal enjoys playing badminton, mastering the guitar, and diving into various books, always eager to explore new ideas and concepts.

## Abstract

Post Traumatic Stress Disorder (PTSD) is a mental health condition triggered by exposure to traumatic events. These traumatic events could range from natural disaster traumas to abuse and war traumas. PTSD is usually found in individuals who have served their nation but can be found in anyone who has been exposed to trauma. It is important to understand the causes of PTSD as many individuals suffer improper sleeping patterns and hypervigilance and try to detach themselves from the world. The purpose of this paper is to describe what PTSD is, how it can affect memory loss, and how it can form false memories. PTSD can be harmful if untreated, especially if the patient is isolated. Neurologists have identified that PTSD can cause memory loss and can create false memories; however, treatments for PTSD are developing rapidly such as EMDR which can reduce the probability of developing memory loss and false memories in the future.

## Introduction

Post Traumatic Stress Disorder (PTSD) is a mental health condition triggered by exposure to traumatic events. These traumatic events could range from natural disaster traumas to abuse and war traumas. Although PTSD is mainly found in veterans, it does not prevent any average citizen from experiencing the same traumatic events. Although PTSD can be observed in normal citizens and veterans, it is most commonly found in frontliners. Around 14 to 16 percent of veterans experience a form of trauma or PTSD while 9.8 percent of the general population experiences PTSD (Loignon et al., 2019). PTSD can also affect one group of people differently than the other because of the psychology of the patient's brain (Bücken et al., 2022). The side effects of PTSD are hypervigilance, trouble sleeping, aggressive behavior, and deteriorating overall mental health. There have been many cases where patients with PTSD have struggled to remember a past situation, whether it was the traumatic incident they went through or short-term memory loss (Joshi et al., 2019).

PTSD can be associated with difficulties in memory retention and recall. This means that the retrieval process of creating memories is being affected because of the patient's psychological distress. PTSD can also lead to the creation of inaccurate or distorted memories (Otgaar et al., 2017). There have been cases where PTSD patients have created false memories about their traumatic moments, making them vulnerable to misbelief and misinformation. There have been many studies showing that patients suffering from trauma are more likely to develop false memories than healthy individuals (Bücken et al., 2022). These false memories can be dangerous to court cases, making judges make wrong decisions. In this paper, I will discuss what PTSD is from a psychological perspective and the numerous treatments that are available for patients, as well as each treatment's effects. I will also be conveying how PTSD affects premature memory loss as well as structural and functional changes in the brain due to PTSD. False memory formation by PTSD will also be explained as it creates problems in court and the credibility of witnesses.

## What is PTSD?

PTSD is a mental health condition that emerges after someone is exposed to a traumatic event. There has been a long history of scientists trying to define PTSD as an illness starting from the Seven Years' War. Luckily, due to the technology we have today, neuroscientists are trying to identify structural differences and findings in the brains of patients who have PTSD. Although the majority of the population being affected by PTSD are people who have served nations, other people who experience traumatic events can also experience PTSD. Experiencing abuse, war, natural disasters, accidents, and child abuse are factors that could lead to PTSD. PTSD is a critical condition that could affect sleep habits, hypervigilance, and mental health. Although the condition is serious to a patient's mental health, there have been many treatments that can lower or eradicate these side effects.

PTSD was first identified and recorded during the Seven Years' War, also known as the French and Indian War. During this profoundly negative time, terms like "nostalgia" were used to describe the condition of the soldiers (Schrader et al., 2021). Other events throughout history have also caused PTSD rates to rise, such as the Holocaust, the Colonization of Native Americans, and American slavery. One similarity throughout all these events in this list is that trauma was usually dealt with by minorities. Some people's trauma became PTSD while others did not, which is based on the individual psychology and their coping mechanisms (Rumball et al., 2020). In 1919, President Wilson of the United States of America called PTSD "Shell Shock" because it was believed that the artillery shells would put the soldiers into shock. In 1980, it was renamed PTSD by the Diagnostic and Statistical Manual of Mental Disorders (DSM-all). It was at these times when PTSD was being taken more seriously, and neurologists were seriously starting to look for the cause of the condition.

Although PTSD is fairly rare in civilians, it is popular among military veterans as they are exposed to more combat and, therefore, are exposed to trauma (Loignon et al., 2019). PTSD is not limited to military veterans, as there have been many situations in which civilians are exposed to traumatic events such as abuse, natural disasters, and accidents. Approximately

6-7% of the adult United States population and a significant portion of military veterans meet the criteria and are diagnosed with PTSD (Schrader et al., 2021). PTSD can cause impairment in a patient's daily life for more than one month because of the severe distress in sleep patterns and behavioral changes, which take extensive time to change.

To identify structural changes to the brain while experiencing PTSD, neuroimaging such as Magnetic Resonance Imaging (MRI) is used to compare structures to a healthy brain to see if there is a difference in the brain structure which could lead to the various side effects of PTSD (Kunimatsu et al., 2019). These scans and observations are important for neurologists and psychologists to know what exactly they are dealing with when they hear about a patient's side effects to make a proper diagnosis. MRI has identified alterations in the anterior cingulate, amygdala, hippocampus, and insula as being highly reproducible, supporting the role of abnormalities in fear learning and reactions to threats in PTSD (Kunimatsu et al., 2019). These parts assist with memory development, feelings, and decision-making. Using this information, neurologists can infer that memory and behavioral changes can be observed in patients.

There are different types of identity that neurologists can use to make further observations in the structure of the brain. Structural MRI identifies gray matter atrophy and other structural changes to see the change in sizes of the brain or parts of the brain. Functional MRI reveals altered brain activity and connectivity patterns (Kunimatsu et al., 2019). In other words, this shows what parts of the brain are used at a specific point in time. In PTSD, parts of the brain respond differently when the patient is thinking of their traumatic event. Diffusion MRI changes are white matter integrity, which means to take a closer look at the changes in tissues in the brain, generally used in finding a tumor rather than helping with PTSD. These types of MRI scanning can help Neurologists make key observations and help identify more side effects for PTSD.

Although PTSD is a very serious condition, patients can still improve their symptoms and quality of life with psychological treatment (Martin et al., 2021). Trauma-focused therapies are a group of medicines that help patients reduce PTSD and

get into better sleeping habits. These treatments include Prolonged Exposure (PE), Eye Movement Desensitization and Reprocessing (EMDR), Cognitive Processing Therapy (CPT), Narrative Exposure Therapy (NET), and Written Exposure Therapy (Martin et al., 2021). One of the most popular therapies is PE, which helps the patient gradually approach trauma-related memories. It helps the patient face their trauma by talking about it to a psychologist, which helps patients reflect on their incidents. CPT is another therapy approved by many psychologists (Larson et al., 2022). CPT focuses on how a patient's thoughts are impacted by their trauma and teaches them how to look at their thoughts while helping them progress towards recovery. These ways are helpful for the patient to understand their trauma, therefore reflecting on it to improve themselves.

In conclusion, PTSD has a great history behind it, emerging in the Seven Days War and is still trying to be understood to this day. Although neurologists have looked at PTSD differently throughout history, today, they can observe structural differences in the brain using types of MRI scanning. These scans help neurologists observe changes in the brains of patients who have PTSD. Experiencing abuse, war, natural disasters, accidents, and child abuse are factors that could lead to PTSD. Even though PTSD cannot be eradicated, multiple therapies could help lower the symptoms, such as improper sleep patterns. These therapies include Prolonged Exposure (PE), Eye Movement Desensitization and Reprocessing (EMDR), Cognitive Processing Therapy (CPT), Narrative Exposure Therapy (NET), and Written Exposure Therapy (Martin et al., 2021).

## How Does PTSD Lead to Memory Loss?

There have been theories being circulated by neurologists stating that PTSD may be a factor in memory loss. The hippocampus plays a vital role in memory as it holds a patient's short-term memory and transfers it to their long-term memory (Joshi et al., 2019). Any problems in the hippocampus can change how memory is encoded and stored drastically. Some theories suggest that PTSD may reduce the overall size of the hippocampus, while others say that PTSD causes problems in the encoding process of the brain, therefore leading to memory loss (Joshi et

al., 2019). Some say that key systems of PTSD are linked to the failure of memory consolidation (Hein Van Marle, 2015). The traumatic memories that a patient is recalling are mostly not accurate, as intrusive memories can disarrange the original memory.

The changes to the hippocampus can play an important role in the possibility of memory loss in a PTSD patient. Generally, the hippocampus plays an important role in memory and contextual processing. Any alteration in the hippocampus can lead to life-long lasting effects such as memory loss, false memories, and sometimes behavioral changes. Functional neuroimaging studies reveal decreased or comparable hippocampal activation in PTSD patients during memory and fear/extinction learning tasks, typically associated with poorer performance on these tasks (Joshi et al., 2019). Since the hippocampus is not being activated as frequently while doing cognitive tasks, patients can experience loss of memory as they are reflecting upon the stimuli. Resting state connectivity studies show reduced within-network connectivity in the default mode network (DMN) and increased coupling between the DMN and the salience network (SN) via the hippocampus (Joshi et al., 2019).

This explains that since there is reduced internetwork connectivity in the DMN, a stimulus is not the only variable that affects memory over some time. A patient's memory can also be affected without stimuli being present, which means that the patient can suffer anything from mild cognitive impairment to long-term memory loss. Reduced connectivity in the DMN can also mean that there is a decrease in stimuli being encoded in the hippocampus, causing a decrease in memories available to the patient initially (Joshi et al., 2019). PTSD is also associated with smaller hippocampal volumes, which may be a risk factor for developing PTSD. Reduced volume in the hippocampus can also affect the performance of a patient's memory and cognitive thinking (Hein Van Marle, 2015). The reduced volume can also be related to why the frequency of hippocampus activations when presented with a stimulus in PTSD patients is dramatically reduced.

Since the hippocampus is being affected due to PTSD, the conversion of short-term to long-term memories faces many complications and difficulties. Key symptoms of PTSD, such as flashbacks, hypervigilance, and nightmares, are linked to the

failure of memory consolidation. Traumatic memories remain tightly coupled to their emotional charge, leading to fragmented and intrusive recollections (Pitts et al., 2022). Since the memory of the patient's trauma is fragmented, intrusive memories may cause the traumatic memory to evolve or be completely wrong. The patient can be experiencing intrusive thoughts, and therefore, their cognitive functions and memory are deteriorating. Since memory consolidation fails, memories are not properly integrated into the hippocampus, which is why patients are not able to transfer memories from short-term memory to long-term memory. This is what causes long-term memory loss (Pitts et al., 2022). PTSD may impair event perception due to hypervigilance, leading individuals to focus on irrelevant stimuli, which disrupts the processing of relevant information.

For example, someone with PTSD might be distracted by perceived threats while driving, causing them to miss important cues. (Causes patients to misinterpret information and not pay attention while encoding information) (Bisby et al., 2020). This repeated distraction in their brains can cause patients to feel overwhelmed about each task, and they may require assistance with basic activities. Learning from the effects of memory consolidation, neurologists have come up with a theory called memory reconsolidation. Memory reconsolidation offers the potential for novel PTSD treatments. For example, interventions can aim to either enhance or disrupt the reconsolidation process, thereby modifying the emotional impact of traumatic memories. This way, patients can recover with positive interventions, reducing the impact of intrusive and traumatic memories.

As described in this section, PTSD may play a critical role in memory loss in patients who have PTSD. The theory suggested by Joshi explains that the hippocampus had decreased in value when the patient had PTSD. Joshi also observed that the activation of the hippocampus was not as frequent as in a control hippocampus. This causes the disability of memories being recalled, which leads to the failure of memory consolidation. The traumatic memories that PTSD patients go through interfere with the encoding process, causing them to forget memories.

## How does PTSD form false memories?

Traumatic events can cause false memories to form in some patients. These memories are usually formed in patients who falsely deny that they have PTSD and are gullible to believe in conspiracies. Being exposed to traumatic experiences is mentally unhealthy, and there are many factors defining how memories can be altered because of traumatic experiences. Many studies have been done to support this theory; some of them seem promising, while others are criticized by critics. These studies were vital for developing new theories related to the brain's ability to make false memories. EMDR, a PTSD treatment, could be creating false memories in the patients' brains, too.

In a study conducted by Büchen, 126 individuals watched a trauma-related video of a car crash to instill traumatic feelings into the participants. After seeing the traumatic video repeatedly, the participants were separated into two different groups: one group answered all the video-related questions honestly, while the other falsely denied the events that happened in the video, such as where the car crashed, how it crashed, and who should be accused of causing the crash. A week later, the two groups were fed misinformation regarding the car crash and then tested on their memory of the initial car crash. The group of participants who falsely denied details were more likely to forget the proper details of the car crash during the memory test. This supports the denial-induced forgetting effect. The denial-induced forgetting effect is the process in which the patient keeps repeating false information to themselves until it replaces real information. Those who falsely denied details were also more prone to incorporate misinformation into their memory, suggesting that false denials increase susceptibility to false memories. It also means that patients with PTSD are more likely to believe misinformation and conspiracy theories. Overall, The study explains that false denials may lead to forgetting due to cognitive inhibition, where individuals actively try not to think about the event they are denying, leading to reduced accessibility of those memories.

Some PTSD treatments, such as Eye Movement Desensitization and Reprocessing (EMDR),

can help PTSD patients avoid forming false memories. EMDR involves patients recalling traumatic memories while performing lateral eye movements. These small eye movements help the patient reflect on their memories and organize their feelings. While some studies show that EMDR reduces PTSD symptoms, others question the role of eye movements, suggesting that only the desensitization (D) component may be beneficial (Kenchel et al., 2020). Critics like James Ost argue that EMDR lacks solid theoretical foundations and that its eye movement and reprocessing components may not add therapeutic value beyond existing therapies like Cognitive Behavioral Therapy (CBT) (Kenchel et al., 2020). However, other studies find horizontal eye movements (EM) improve memory accuracy and reduce misinformation susceptibility, as seen in other studies (Parker et al., 2009). The effect of eye movements on memory vividness is suggested to play a role where reduced vividness could increase susceptibility to misinformation. The most prominent theory for the benefits of EMDR is the Working Memory (WM) account. Eye movements compete for WM resources, which reduces the vividness and emotionality of traumatic memories, helping in PTSD treatment. False memory creation is a key concern, with research showing that eye movements may increase susceptibility to false memories, particularly when misinformation is introduced after an EMDR session. However, When following the EMDR session properly, patients can lower their chances of forming false memories.

## Conclusion

In conclusion, PTSD has a strong impact on mental health. These impacts can include improper sleep patterns, hypervigilance, and overall well-being. PTSD was first identified during the Seven Years' War as was classified as nostalgia and later was identified as an intense type of psychological trauma. The hippocampus is one of the most important parts of the brain related to memory, and it is affected by either reduction in volume or incorrect memory consolidation. This can cause memory loss and create false memories. EMDR can help reduce the probability of developing false memories or memory loss. On the other hand, ongoing research is required to improve the treatment and limit loopholes that can cause bigger problems. It is important to understand the neurological and psychological aspects of PTSD

to learn more about how to reduce the symptoms of PTSD.

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