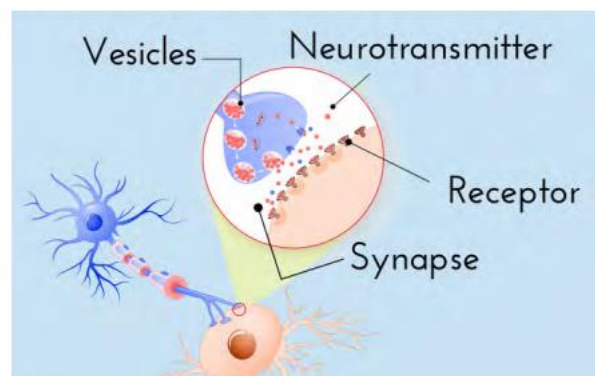


Certain brain chemicals, also called - neurotransmitters - are associated with our well-being. Discuss the ways we can manipulate the levels of our brain chemistry to make us feel better.

Introduction

Our brain is the most complex organ in our body, and the hardest for us to fully understand. According to Dr Fiona Sheppard, our mental wellbeing depends on the concentrations of certain chemicals in our brain. Many factors can put these chemicals back into balance, such as exercise, medicine or using technology. (Dr Fiona Sheppard, 10th August 2023) The different concentrations of these chemicals in the brain together make up our brain chemistry. Brain chemistry can be defined as 'the sum of all the chemical messaging that takes place in the brain, which allows it to carry out its daily functions, such as generating movement, speaking and countless others'. ("Brain Chemistry (Neurochemistry)." Accessed on: July 25, 2023, from Encyclopedia.com). Many mental illnesses are believed to be caused by certain imbalances of chemicals in our brain which affect the overall mental wellbeing of a specific person. However, we can improve our own well-being by exercising or socialising, as each of these activities release certain chemicals in our brain which in turn help maintain the correct concentrations of these and other chemicals in the brain. (Dr David Watson, a Behavioural Psychopharmacologist, 21 August 2023)

These chemicals which make up our brain chemistry can also be referred to as neurotransmitters. Neurotransmitters are produced in the cell body of a nerve and are stored within thin-walled sacs called synaptic vesicles (shown in figure 1). Each of these vesicles contain thousands of neurotransmitter molecules. (Cleveland clinic, 2021, Accessed on: 26th July 2023) These neurotransmitters are stored at and released from the axon terminals of cells into a fluid filled space between two neurons called a synapse. Upon the arrival of a nerve impulse, neurotransmitters are released to help diffuse the impulse across the synapse and then they bind to specific receptors on the other side of the synapse on the other neuron and the impulse continues travelling. This ensures that all impulses travel in only one direction. The different types of neurons which impulses travel across are relay neurons, motor neurons or sensory neurons.



Illustrations by Elizabeth A. Weaver II

Figure 1
(Sukel, Dana foundation, Neurotransmitters, 2019)

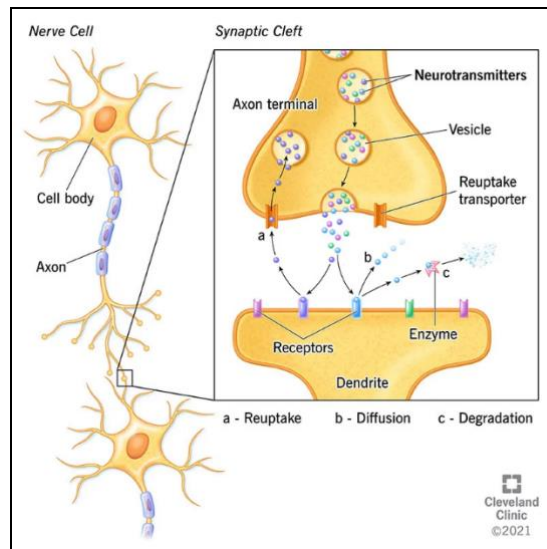


Figure 2
(Cleveland Clinic, 2021)

Once neurotransmitters have successfully bonded with the receptor on the target neuron, they can either fade away through the process of diffusion, be reabsorbed through the process of reuptake, or be broken down by enzymes which reside in the synapse so that they can no longer be recognised and bind with any other receptors (degradation) as shown in figure 2.

There are different categories of neurotransmitters depending on their functions in the body's daily processes. The three main functions of neurotransmitters are: Excitatory, Inhibitory, and Modulatory. Excitatory neurotransmitters 'fire off the message' (Cleveland clinic, 2021, Accessed on: 26th July 2023) which allows it to continue the impulse to the next neuron. Examples are glutamate, epinephrine, and norepinephrine. Inhibitory neurotransmitters block or prevent chemical messages from being carried along neurons any further. Examples are serotonin, GABA, and glycine. Modulatory neurotransmitters adjust how cells communicate at the synapse. Examples are histamine, dopamine, and cannabinoids. (Cleveland clinic, 2021, Accessed on: 26th July 2023) Each of these neurotransmitters have specific functions as well as general functions which they are involved with in the daily bodily processes.

There are many ways in which the concentrations of these neurotransmitters can be manipulated to improve our wellbeing and make us feel better. These include taking medication, using technology, and different lifestyle choices, all of which will be discussed later in this essay.

Neurotransmitters

There are specific neurotransmitters that scientists and doctors believe are linked to certain mental illnesses. For example, different concentrations of the neurotransmitter serotonin are said to cause depression, different concentrations of dopamine are said to be linked to Parkinson's disease, and different concentrations of the neurotransmitter GABA is said to be a causing factor of OCD and anxiety. (Vasković, 2023) However, do we know enough about these neurotransmitters and

their effects on our well-being? When this exact question was posed to Dr Fiona Sheppard, a doctor working for the NHS, she said 'I don't think we do to be honest'. She also continued to say how neurotransmitters worked in many ways and each had many different receptors. An example she gave was serotonin which she said had more than 7 receptor subtypes. (*Dr Fiona Sheppard, 10 August 2023*) From this it can be said that there is a lot to learn about these neurotransmitters and that we may not necessarily know everything about them at the moment. Therefore, their roles in certain mental illnesses may not be completely understood and we may not be fully capable of actively manipulating their concentrations in the brain using medicines. In addition, we are still unsure whether these medicines, that people take to make them 'feel better', would not cause any further damage to their brains and memories as they grow older.

On the other hand, Dr Julien Reboud, a Reader in Biomedical Engineering, when asked the same question during an interview, exclaimed 'we know tons, it's amazing!' (*Dr Julien Reboud, 27 July 2023*) It can be implied that we know a lot about neurotransmitters, but we may not know everything that we should know about them to be able to manipulate their concentrations in our brain, knowing that no other harm to our body or well-being will be caused. Dr David Watson, a Behavioural Psychopharmacologist, said that we may already know a lot about neurotransmitters, but there is still a lot more for us to learn about them which could help us to make medications to reduce the amount of side effects suffered by patients in the future. (*Dr David Watson, a Behavioural Psychopharmacologist, 21 August 2023*) However, since we do know quite a lot about them already, we are able to create medications which serve their purpose to alleviate symptoms and, sometimes, cure patients.

Manipulating our brain chemistry

There are many ways in which we can manipulate the chemicals in our brains, neurotransmitters, and, overall, our brain chemistry. Firstly, there are lifestyle choices. What people choose to eat, when people socialise and exercise all affect a person's overall well-being and therefore, the concentrations of the different neurotransmitters produced in their brains. For example, a person who exercises a lot will release more endorphins, a neurotransmitter that 'alleviates pain and promotes pleasure', than a person who sits around all day watching TV. (*Cpt et al, 2023*) A person who therefore exercises more releases more endorphins, making the person feel happier and less depressed, boosting their mental well-being and increasing their brain activity as shown in the graphs in figure 3.

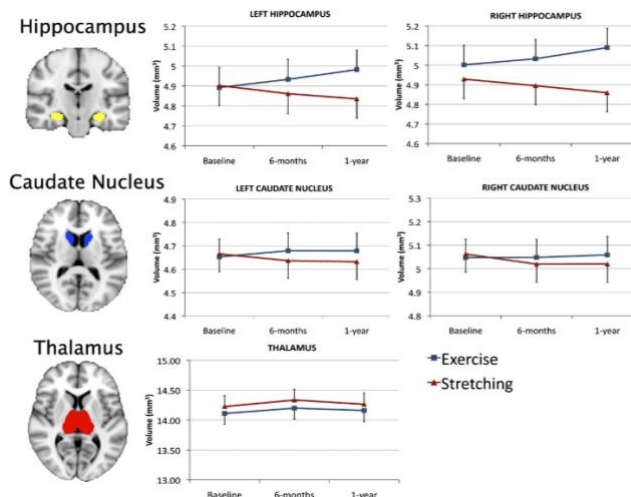


Figure 3

This shows the affect of aerobic exercise on the volume of blood going to that part of the brain showing increased brain activity therefore an increase in the release of certain neurotransmitters. (Erickson et al, 2011)

When a person's mental state deteriorates to the point that changing their lifestyle choices will not affect their overall wellbeing, medication can be used. Medication can increase or decrease the concentration of certain neurotransmitters in the brain to make a person feel better. However, these medicines only work for a period of time. Dr Julien Reboud explained that people 'start on low doses and wait to see what happens'. Nevertheless, it is a 'constant struggle' to find the correct dose because once the correct dose is found, while the person will start to feel better as these medications alleviate their symptoms, unfortunately this will only last for a short period of time. This is because the brain will adapt to resist the medication, so the dose then must be changed, either increased or decreased. (Dr Julien Reboud, 27 July 2023) This shows how short-term medication can be as a fix, as its dose is constantly having to change to catch up with the brain constantly adapting and making the old dose no longer effective. Although medication, when the correct dose is used, can be extremely effective in treating mental illnesses and helping patients to feel better, not only must the dose be constantly adjusted but there will also come a point when the dose becomes so high as to become toxic for a human, therefore the patient will be unable to take it anymore. Therefore, medication is given to patients once all other possible treatments have been exhausted. (Dr Julien Reboud, 27 July 2023)

Not all medications that can be used to manipulate our brain chemistry are legal. Illegal drugs also manipulate the concentrations and levels of certain neurotransmitters in our brain when consumed. An example is cocaine. Cocaine triggers the release of dopamine in the brain causing the person to feel the 'rewarding feeling', as discussed later in this essay, without doing anything. This causes the drug to be highly addictive as when a person comes back down from feeling euphoric or 'high' they 'crash' and feel depressed and so are drawn to taking more. (Better health channel, 11-08-22)

Technology presents us with yet other ways in which we can manipulate our brain chemistry. These include vagus nerve stimulation (VNS), transcranial magnetic

stimulation (TMS), deep brain stimulation (DBS), electroconvulsive therapy (ECT) and many more. VNS excites a specific nerve pathway which then will release neurotransmitters in a certain way. TMS can affect the chemistry of the brain almost everywhere except deep in the brain. This process can only be done on the surface and near to the skull. See figure 5. DBS is the method where the brain is opened, and electrodes are placed inside (figure 4 shows how the electrodes are placed inside the brain and the overall setup). This normally occurs in dire circumstances where a person has Parkinson's disease or severe epilepsy to the point where they are unresponsive. (Dr Julien Reboud, 27 July 2023) However, although all these methods are reliable and work, the brain will always adapt to bypass the treatment so that eventually the procedure will no longer change the concentrations of the neurotransmitters in the brain in the correct way, just like with medication. DBS poses an extra worry as it is a 'bridge between the outside and the inside of the body', said Dr Julien Reboud. (Dr Julien Reboud, 27 July 2023) This is not dangerous when it comes to manipulating our brain chemistry, however it does increase the chance of infection in the brain which can cause many unnecessary issues and problems. There is also another major issue with these procedures. The treatments work but, as said by Mayo clinic, 'More study is needed to determine whether TMS may have long-term side effects. (Mayo clinic, 2023) This shows how there is more research to be done in this field to better our understanding as to the long-term side effects of these treatments, for example TMS.

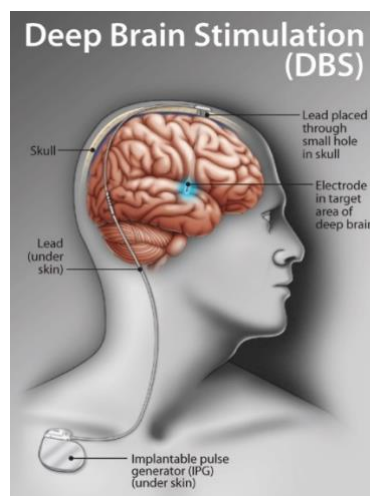


Figure 4
(Defepiadmin, 2022)

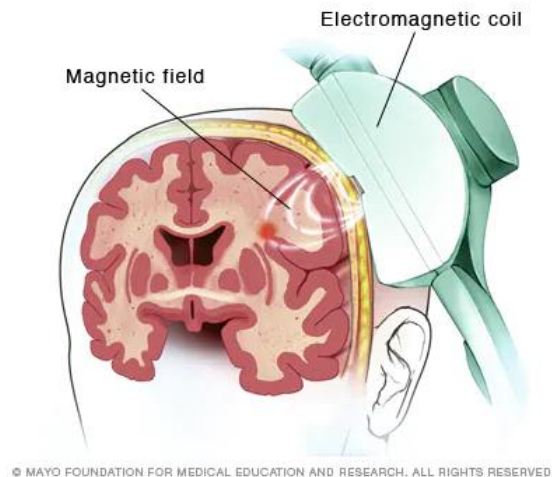


Figure 5
(Mayo clinic, 2023)

Serotonin

A well-known neurotransmitter is serotonin. Serotonin is a chemical which is released to 'reward a person when they gain a social advantage'. This means that when someone feels inferior then the levels of serotonin in their brain decreases. A lack of serotonin will make a person feel 'exhausted and defeated' and cause them to lose hope. (*Brooke Castillo, Life coach school, Neurotransmitters ep. 239 [podcast], October 25, 2018*) Therefore, serotonin regulates a person's mood and how they feel in social interactions and in public areas. Balanced levels of serotonin in the brain are healthy, however, high levels of serotonin in the brain are said to cause serotonin syndrome, whereas low levels of serotonin can be said to lead to depression.

The paper by B Ang et al about serotonin and its involvement in causing depression, discusses how this common concept could be an 'urban legend'. It suggests there is not enough evidence to show that the concentration of the neurotransmitter serotonin in the brain is directly linked to depression. (Ang, Horowitz, and Moncrieff, 2022) From this, we can see that we do not know as much about these neurotransmitters and their effects on a person's wellbeing as well as we thought we did. Dr Julien Reboud, when asked about this, explained how different concentrations of different neurotransmitters caused a change in levels of other neurotransmitters. (*Dr Julien Reboud, 27 July 2023*) Therefore, it may be numerous neurotransmitters whose concentrations influence each other's concentrations causing a type of 'chain reaction' to occur.

As discussed above, many lifestyle changes could be made to help a person to improve their wellbeing and make them feel 'rewarded' once they have achieved something socially. Both lifestyle changes and the different procedures discussed above, can also help alleviate symptoms of mental illness said to be caused by serotonin, for example depression. However, if these other treatments are not as effective or the patient has become suicidal due to depression, then medication can be used. With depression specifically, antidepressants are used to increase the levels of serotonin in a person's brain. These may work wonders for a period of time,

but as mentioned above, not only can the correct dose be hard to find, but the brain is also constantly adapting leading to the medication becoming no longer effective.

Dopamine

Another well-known neurotransmitter is dopamine. As described in a podcast about the importance of certain neurotransmitters, dopamine is a chemical which is released in our brain when we are craving something, for example when we crave eating chocolate. However, after eating some chocolate, the flow of dopamine stops. 'The pleasure of the reward is a different type of pleasure than the pleasure of anticipating that reward'. The pleasure of anticipating that reward is caused by the neurotransmitter dopamine, whereas the after pleasure is caused by another neurotransmitter. (*Brooke Castillo, Life coach school, Neurotransmitters ep. 239 [podcast], October 25, 2018*). This shows the importance of dopamine to our wellbeing as dopamine is one of the main neurotransmitters which creates motivation in living creatures as it gives them the sense that they can achieve more in their life and gain more achievements knowing that they will be rewarded once they achieve that specific goal.

However, people can misuse the chemical dopamine as they consistently indulge in activities which would have been a 'reward' for them. This could be from eating a lot of chocolate to taking drugs. When people constantly reward themselves, the feeling they get when they are anticipating the reward vanishes as it is no longer needed since the reward is carried out daily. This can harm a person's well-being. Since dopamine gives people the motivation and the will to live on, without feeling its effects occasionally, a person could feel less focused on their aims and goals as they do not need to accomplish anything to get the rewards which they indulge in regularly. (*Brooke Castillo, Life coach school, Neurotransmitters ep. 239 [podcast], October 25, 2018*)

A lack of dopamine can be said to lead to Parkinson's disease. It was found that low levels of dopamine in the brain, also referred to as 'dopamine deficiency', may be a contributing factor in the cause of Parkinson's disease in certain individuals since it 'seemingly participates directly or indirectly in almost all physiological functions occurring in the central nervous system'. (*Franco, Reyes-Resina and Navarro, 2021*) Therefore, it can be said that dopamine's presence in the brain is more important than we initially thought and its use in making people feel the pleasure of anticipating a reward is vital for us living our lives and keeping us always motivated, alert and reaching for our goals.

There are many ways that dopamine levels can be manipulated to relieve a person of the symptoms of a certain disease that may be caused by either a lack or abundance of dopamine. Medication is sometimes given to patients to either help increase or decrease the concentration of dopamine in their brain. Pramipexole is an example of one such medication, which is used to increase levels of dopamine in the brain. However, medicine is not the only way. To help regulate a person's dopamine levels, all a person needs to do is ensure that they do not indulge regularly in activities which would be a 'reward' for their hard work. For example, occasionally eating sweets and only drinking alcohol on special occasions. Therefore, it can be said that a person can regulate their own levels of dopamine by doing things they

enjoy in moderation, and only when they feel a craving from a surge in dopamine can they then indulge in these pleasurable activities. (*Brooke Castillo, Life coach school, Neurotransmitters ep. 239 [podcast], October 25, 2018*)

GABA

An inhibitory neurotransmitter is Gamma-Aminobutyric acid (GABA). These specific neurotransmitters are responsible for helping us to control our thoughts by blocking certain thoughts and memories when they are unnecessary at that moment. Many mental illnesses are caused by too much or too little GABA in the person's brain. These mental illnesses include schizophrenia, OCD and PTSD. In an article discussing the importance of GABA, Dr Michael Anderson said 'Our ability to control our thoughts is fundamental to our wellbeing. When this capacity breaks down, it causes some of the most debilitating symptoms of psychiatric diseases. (*University of Cambridge, Scientists identify mechanism that helps us inhibit unwanted thoughts, 2017*) This highlights the importance of GABA to our mental wellbeing.

In the book 'The Brain that Changes Itself', Norman Doidge discusses many illnesses and how they affect the lives of people daily. In one chapter of his book, he discusses how much OCD can have a major impact on people's lives to the extent that they are constantly stressed and panicked. He describes how people with OCD gain 'checking compulsions' as they constantly need to check whether they have done something or not, for example locking the front door. (Norman Doidge, 2008) This would distract the person from their everyday lives and constantly make them feel unsafe and in danger. In his book, Doidge says how Jeffrey M. Schwartz 'has developed an effective, plasticity-based treatment that helps not only those with obsessive-compulsive disorder but also those of us with more everyday worries, when we start stewing about something and can't stop even though we know it's pointless.' (Norman Doidge, 2008) This is one of the treatments that has been found to help manipulate the levels of GABA in the brain and has helped alleviate the symptoms of people suffering with OCD.

Anyone who regularly socialises and exercises, gets better sleep, has happier moods, and can manage their stress and anxiety. (*Mind, Physical activity, and your mental health - About physical activity, accessed on: 25 August 2023*) Machines and medicine are used in extreme cases where a person's state may cause a threat to their lives or others.

Conclusion

Overall, neurotransmitters can be manipulated in a variety of ways. This can be as simple as changing a person's lifestyle, to using machines, to medication. To different extents, each of these methods are effective in relieving patients of their symptoms and making them feel more 'normal'. Ultimately, however, once all avenues have been exhausted, medication seems to be the most effective at managing patients' symptoms. That said, more research still needs to be done into the potentially harmful long term side effects of some of these treatments. In addition, I believe that although we know a lot already about the different neurotransmitters, and the part they play in how people feel, it is important that research continues to be done so that we may gain a full and complete

understanding of them and reduce the amount of side effects suffered by the patients from undergoing certain treatments. Furthermore, we know that the various available treatments' effects on the brain only last for a specific amount of time. It is therefore hoped that further study will enable us to extend the amount of time a certain dosage relieves a patient's symptoms, as well as lengthening the period of time before that patient reaches the toxic threshold of their medication, thus enabling them to benefit from the medication for much longer.

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