RECOVERY SESSION: THE NEUROSCIENCE OF EATING DISORDERS



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OK SO...WHAT IS NEUROSCIENCE?

As with many science-y things, 'neuroscience' is a term that I might hear and nod along with with a vague understanding of the word, but if someone asked me to explain it (like in a Body Brave handout or something) I would probably require a bit more information about what neuroscience *actually* is. So here it goes!

Neuroscience is the study of the nervous system, which is basically the body's command centre (includes the brain and all it's components, as well as the spinal cord). So neuroscience looks at the nervous system, how it develops and what it does.

When it comes to neuroscience and mental health, scientists mainly focus on the brain and its impact on behaviour and cognitive functions. So they look at how brain cells signal to each other (ex. which chemicals they use); they study how brain cells connect to each other (ex. by sending small electrical pulses); and they study whole systems of brain cells at work (ex. looking at connected activity in the visual areas of the brain, the auditory areas of the brain and the thinking areas of the brain).

There are lots of types of neuroscience and the one we will explore is cognitive neuroscience, which is the study of higher cognitive functions that exist in humans and their underlying neural bases.

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Still confused? Me too. If looking at the big 'neuroscience' picture isn't helpful don't worry, we're going to zero in on the important stuff in the rest of the handout!



"This is not your fault. This is not a disorder of control. There is a genetic underlying that triggers this neurobiological process that distorts how your body responds to food and how your brain thinks about your body."

- James Greenblatt



THE TROUBLE WITH NEUROSCIENCE

An important thing to keep in mind when learning about the science of eating disorders and research into the neuroscience of mental health, is that it's really hard for scientists to be able to tell if something they find is a CAUSE of an eating disorder or a CONSEQUENCE of an eating disorder (these are known as 'traits' or 'scars' in fancy science talk).

Basically, it's hard to tell which came first: the eating disorder/disordered eating or the change in brain chemistry. Are our brains different as a result of disordered eating behaviours/symptoms? Or are we struggling with these behaviours/ symptoms because of differences in our brain chemistry? In many cases it can be really hard to tell for sure, so it's important to keep that in the back of your mind while learning about the science side of eating disorders. There's still a lot we don't know.

Reynolds, P. (2020). The Biology Behind Eating Disorders. IEEE Pulse. Retrieved from https://www.embs.org/pulse/articles/the-biology-behind-eating-disorders/.



NEURONS & EATING DISORDERS

Neurons is the fancy name for 'nerve cells', which are the cells that send and receive signals to your brain. We like neurons, they do lots of good things for us and help to keep us functioning. It's estimated that the human brain is home to about 86 billion neurons.

There are different types of neurons that do different things:

- Sensory neurons: These help us to smell, hear, taste, see, and feel. Sensory neurons are triggered by physical and chemical inputs from our environment. Sound, touch, heat, and light are physical inputs. Smell and taste are chemical inputs. For example, stepping on hot sand activates sensory neurons in the soles of your feet. Those neurons send a message to your brain, which makes you aware of the heat. Thanks little neuron dudes!
- Motor neurons: Motor neurons play a role in movement, including voluntary and involuntary movements. These neurons allow the brain and spinal cord to communicate with muscles, organs, and glands all over the body. These neurons control things we think about doing or notice, as well as parts of our day to day functioning that we have no awareness of (smoothing muscles in preparation for eating, etc). Great multitaskers (my words, not sciences, though I think science would agree)!
- Interneurons: These are the most common little neuron friends we have, they are neural intermediaries found in your brain and spinal cord. They pass signals from sensory neurons and other interneurons to motor neurons and other interneurons. They kind of make really fancy circuits to help us react to things around us. For instance, when you touch something sharp, sensory neurons in your fingertips send a signal to interneurons in your spinal cord. Some interneurons pass the signal on to motor neurons in your hand, which allows you to move your hand away. Other interneurons send a signal to the pain centre in your brain, and you experience pain.

There's a lot more complex things and words and stuff that goes along with these topics. If you're interested I highly recommend looking it up! Otherwise, these are the parts that I thought were interesting and was like "huh, that's kind of cool! maybe other people who don't understand science but find this kind of interesting would like!"

Steinglass, J. E., Berner, L. A., & Attia, E. (2019). Cognitive Neuroscience of Eating Disorders. The Psychiatric clinics of North America, 42(1), 75–91.



NEUROTRANSMITTERS

Okay so you're an expert at neurons now, so when I talk about the 'signals' neurons send to each other, you know exactly what I'm talking about. So those 'signals' are sent to each other using chemicals called 'neurotransmitters'. It's the type and amount of a neurotransmitter that's released that lets a neuron tell their neighbouring neurons what's going on.

Now we get a bit more involved, so bare with me. For eating disorders there are two primary neurotransmitters you need to know about: serotonin and dopamine. Each of these neurotransmitters has an influence in how we think and behave, our personalities, and even perhaps our risk for developing an eating disorder.

Serotonin:

Serotonin is a neurotransmitter that kind of helps act as a mood stabilizer in some ways. It helps control everything like memory, learning, sleep, emotions, motor skills, and appetite. Serotonin can be found LOTS of places throughout your body:

- **Brain:** Serotonin in the brain is thought to regulate anxiety, happiness, and mood. Low levels of the chemical have been associated with depression, and increased serotonin levels brought on by medication are thought to decrease arousal.
- **Bowels:** Serotonin is found in the body's stomach and intestines. It helps control your bowel movements and function.
- **Blood:** Blood platelets release serotonin to help heal wounds. The serotonin causes tiny arteries to narrow, helping form blood clots.
- **Bones:** Serotonin plays a role in bone health. Significantly high levels of serotonin in the bones can lead to osteoporosis, which makes the bones weaker.

Dopamine:

Dopamine is a neurotransmitter that plays a huge role in how we feel pleasure, it helps us to strive, focus, and find things interesting! It is involve in rewardmotivated behaviour (studying to get good grades, or going to work early to get a raise), and creates a sort of motivation-reward-reinforcement cycle.

Additionally, dopamine helps regulate movement, memory, hormones and pregnancy, sensory processing. pain processing, heart and kidney function, to name a few!



**Important note: a lot of eating disorder studies use women exclusively as participants. Sometimes science can be silly and sexist, so keep that in mind.

Serotonin and Eating Disorders

Results of studies on eating disorders and serotonin differ a lot depending on the exact behaviour that is being studied.

When looking at binge eating behaviour:

- One study found that when going without food for longer periods of time (such as during sleep), those with bulimia had a larger drop in serotonin levels than women without eating disorders, which led to binge eating and increased irritability (Steiger et al., 2001).
 - Individuals with bulimia often crave foods rich in carbohydrates, suggesting low levels of serotonin in the brain.
- Researchers generally believe that individuals with BED also suffer from chronically low serotonin levels, which is thought to contribute to binge eating in an attempt to relieve the depressed mood caused (in part) by this low serotonin (Haedt-Matt & Keel, 2011).
- This is part of why antidepressants that specifically increase serotonin levels are sometimes prescribed for those struggling with bulimia or BED, as they can result in reduced episodes of binge-eating.

When looking at restrictive behaviour:

- In 2009 one researcher hypothesized that restriction actually makes people with anorexia feel better by decreasing the serotonin in their brains (Kaye, Fudge, & Paulus, 2009).
 - As they continue to starve themselves, however, the brain responds by increasing the number of serotonin receptors to more efficiently utilize the remaining serotonin. So in order to keep feeling better, the person needs to starve themselves further, creating the illness's vicious cycle. When someone with anorexia starts eating again, however, serotonin levels spike, causing extreme anxiety and emotional chaos, which makes recovery difficult without adequate support.'

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Dopamine and Eating Disorders

Results of studies on eating disorders and dopamine also differ a lot depending on the exact behaviour that is being studied.

When looking at binge eating behaviour:

- Binge eating disorder has been linked to a hyper-responsiveness to rewards such as food, which makes eating more rewarding and pleasurable than in people without this disorder (Davis et al., 2012) and leads to a continuation of compulsive overeating (Bello & Hajnal, 2010).
- Research has shown that bulimia is associated with lower levels of both dopamine and certain of its receptors, and that binge eating is significantly associated with dopamine release in certain parts of the brain (Broft et al., 2012).

When looking at restrictive behaviour:

- In anorexia, the leading hypothesis is that the disorder is associated with an over-production of dopamine, leading to anxiety (Bailer et al., 2012a), harm avoidance (Bailer et al., 2012b), hyperactivity and the ability to go without pleasurable things like food (Kontis & Theochari, 2012).
- In other studies, lower levels of dopamine have been found in women with anorexia.



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Haedt-Matt, A. A., & Keel, P. K. (2011). Revisiting the affect regulation model of binge eating: A meta-analysis of studies using ecological momentary assessment. Psychological bulletin, 137(4), 660. doi: 10.1037/a0023660

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Broft, A., Shingleton, R., Kaufman, J., Liu, F., Kumar, D., Slifstein, M., ... & Walsh, B. T. (2012). Striatal dopamine in bulimia nervosa: A pet imaging study. International Journal of Eating Disorders, 45(5), 648-656. DOI: 10.1002/eat.20984

Bello, N. T., & Hajnal, A. (2010). Dopamine and binge eating behaviors. Pharmacology Biochemistry and behavior, 97(1), 25-33. doi: 10.1016/j.pbb.2010.04.016

Bailer, U. F., Narendran, R., Frankle, W. G., Himes, M. L., Duvvuri, V., Mathis, C. A., & Kaye, W. H. (2012). Amphetamine induced dopamine release increases anxiety in individuals recovered from anorexia nervosa. International Journal of Eating Disorders, 45(2), 263-271. DOI: 10.1002/eat.20937

Bailer, U. F., Frank, G. K., Price, J. C., Meltzer, C. C., Becker, C., Mathis, C. A., ... & Kaye, W. H. (2012b). Interaction between serotonin transporter and dopamine D2/D3 receptor radioligand measures is associated with harm avoidant symptoms in anorexia and bulimia nervosa. Psychiatry Research: Neuroimaging. doi:10.1016/j.pscychresns.2012.06.010

Kontis, D., & Theochari, E. (2012). Dopamine in anorexia nervosa: a systematic review. Behavioural Pharmacology, 23(5 and 6), 496-515. doi: 10.1097/FBP.0b013e328357e115



REGIONS OF THE BRAIN

Limbic System

The limbic system is the part of the brain involved in feeling and reacting, especially when it comes to behaviours we need for survival like eating, reproduction, and stress responses. There are two major structures in the limbic system: the hippocampus and the amygdala.

Hippocampus: The hippocampus plays a major role in the formation, organization, and storage of new memories as well as connecting certain sensations and emotions to these memories (like how certain smells can bring up old memories).

Amygdala: The amygdala is best known for its role in processing fear and our "flight-fight-freeze-fawn" responses. This section of the brain activates with stress and fear, and sends neurons to the rest of the brain to activate our <u>stress</u> <u>responses</u>.

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In states of stress, when the amygdala is activated, it causes some of the other parts of our brains to go offline for a bit to help maintain those survival instincts. For a lot of us struggling with eating disorders we kind of live in a constant state of fear and stress, which means many important areas of the brain are turned off and not being utilized or strengthened.

When the amygdala is in overdrive it has a domino effect on other areas of the brain, including the hippocampus (where a lot of our memory/learning lives). So when a person is highly stressed memories can start to get a little clouded and fuzzy.

This, in turn, can create more stress, more activation of the amygdala, and continued lack of proper functioning of the hippocampus. The more often this happens, the smaller the hippocampus becomes because cortisol, the stress hormone, erodes the hippocampus.

And this all ties into...

The limbic system. Queensland Brain Institute. (2019, January 24). Retrieved from https://qbi.uq.edu.au/brain/brainanatomy/limbic-system#:~:text=The%20limbic%20system%20is%20the,and%20fight%20or%20flight%20responses.

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Nucleus Accumbens (aka the Reward Centre of the Brain)

The nucleus accumbens is found in an area of the brain called the 'basal forebrain', and it's most widely recognized for it's role in the "reward circuit" of the brain. So when we do anything that is considered 'rewarding' or pleasurable (things like eating food, having sex, etc) dopamine neurons in this area of the brain become activated (which means that we feel good!).

When conditions like eating disorders or addictions are introduced though, we can run into dangerous territory here. Eating disorder behaviours, substance abuse, or other additions can cause the nucleus accumbens to hyperactivate.

This area of the brain is not designed to be overactive, and when it is functioning in a healthy way, it will activate at low to moderate levels. To try to support the brain function when the nucleus accumbens area of the brain is in overdrive, **the amygdala is temporarily quieted and shut down**. This has the side effect of taking away pleasure from everyday activities and hobbies that moderately activates the nucleus accumbens.

This can help explain why when we are struggling with an eating disorder we lose interest in a lot of other important things in our lives, like hobbies, even relationships.

"In recovery, an individual with an eating disorder needs to grieve the loss of experiencing this relief [of disordered eating behaviours] and practice experiencing joy and satisfaction from everyday life pleasures."

- Camille Williams

Insula

Okay one more cool brain thing before we go! Another part of the brain that is really important but can get turned off in times of high stress or fear is called the 'insula'. The insula isn't as well researched as other parts of the brain, but basically it facilitates our concept of self-awareness, including awareness of our bodies and our emotions and our perception of these things. It also plays a role in taste sensations. Much to think about when we're considering how we feel when we are struggling with an eating disorder, why we feel we lose ourselves.

Williams, C. (2018, June 8). The brain and eating disorders - can the brain be repaired? Eating Disorder Hope. Retrieved March 4, 2022, from https://www.eatingdisorderhope.com/blog/brain-eating-disorders-can-brain-repaired





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★ Time to Reflect

How does knowing that there are scientific and biologic components to the disordered eating that you experience make you feel? How does it make you feel about working towards recovery?

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AFFIRMATIONS

Normally we include a few affirmations to try out! This time along with those affirmations we're going to look at the SCIENCE of affirmations too (I mean I'm here with my little lab coat and microscope, we may as well)!

The Science of Affirmations

Affirmations are thoughts you intentionally use to support, encourage, and calm your brain and body. They can be positive statements used to challenge negative, depressing, or anxiety-producing thoughts and beliefs. They can also just be general supportive thoughts providing yourself encouragement.

When we have any thought, there is a burst of neurochemicals in our brains. Patterns form as those neurochemicals move, and they are connected by 'synapses', which basically form fancy little chemical bridges. The more we have a particular thought, the quicker and stronger the synapses pass along that message. In addition, the emotions we attach to specific thoughts become more automatic and powerful the more often we repeat those thoughts. That's how positive affirmations can affect our brain's natural processes and help us to think in more positive ways, by practicing and helping out our brain to build those chemical bridges!

Affirmations to Try

One small positive thought in the morning can change my whole day. So today I rise with the knowledge that...

- I have the skills and tools I need to recover.
- I am going to forgive myself and free myself. I deserve to forgive and be forgiven.
- I do not engage with people who enter my space with unhelpful thoughts and ideas-I walk away when a person or a situation isn't healthy for me.
- I finish what matters and let go of what does not.
- My life has meaning. What I do has meaning. My actions are meaningful and inspiring.

What I have done today was the best I was able to do today. And for that, I am thankful.

Steinglass, J. E., Berner, L. A., & Attia, E. (2019). Cognitive Neuroscience of Eating Disorders. The Psychiatric clinics of North America, 42(1), 75–91.

Frank, G., Shott, M. E., & DeGuzman, M. C. (2019). The Neurobiology of Eating Disorders. Child and adolescent psychiatric clinics of North America, 28(4), 629-640.



FURTHER LEARNING

Podcasts

Psychiatry & Psychotherapy Podcast: An Inside Look at Eating Disorders

<u>The Eating Disorder Therapist: Understanding More about the Psychology of</u> <u>Eating Disorders</u>

The Eating Disorder Trap Podcast: Neuroscience and Neurobiology

TED Talks

Christina Costa: How gratitude rewires your brain

Kay M. Tye: What investigating neural pathways can reveal about mental health

David Anderson: Your brain is more than just a bag of chemicals

Allan Jones: A map of the brain

Carol Dweck: The power of believing that you can improve

People to follow:

- Dr Anita Federici @drantiafederici
- Centre for Psychology & Emotion Regulation @centreforpsychandemotionreg
- Frank Pew @pewpsychotherapy
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- Rachel Millner @drrachelmillner