## Science fair - Tiara H. and Shraavya H.

How does music influence mental illness, and why is it an effective tool?

**Hypothesis**

We hypothesize that music can help reduce the symptoms of mental illness by regulating brain activity, improving mood, and lowering stress hormones. We also believe that different types of music can affect how a person feels and connect with their environment.

We hypothesize that listening to music can reduce symptoms associated with mental illness by influencing neurological and physiological processes in the brain. Specifically, we predict that music regulates brain activity in areas associated with emotion and reward, increases positive mood states through the release of neurotransmitters such as dopamine, and lowers physiological stress responses by reducing stress hormones like cortisol.

We hypothesize that music can help reduce the symptoms of certain mental illnesses by influencing brain activity, improving mood, and lowering levels of stress-related hormones such as cortisol. We predict that listening to music may stimulate areas of the brain associated with emotion regulation and reward, which can promote feelings of calmness and well-being. Additionally, we believe that different genres or tempos of music may produce different emotional responses, affecting how individuals feel and how they interact with their environment.

**Prediction 1**

We predict that listening to music can reduce symptoms of anxiety and depression by lowering cortisol and slowing your heartbeat, which can calm down individuals and make them feel calmer, happier, less stressed and reduce loneliness.

**Prediction 2**

Our second prediction is that music may help individuals who suffer from schizophrenia by reducing the intensity of schizophrenic episodes and reducing emotional distress.

**Prediction 3**

Our third prediction is that music can help people who suffer from PTSD process traumatic memories and experiences, regulate moods, and make their environment feel safer.

**Prediction 4**

The type of music can change how it affects the person; for example, someone with PTSD might experience high levels of anxiety if they are listening to music that talks about difficult subject matter.

**Extension of our questions**

If we have time, an extension of our question would be how music affects children's development and how music affects people who suffer from Alzheimer's and dementia.

# How music resonates with the brain

**Shraavya Hoysal and Tiara Hiebert**

**General topic**

**(How does music affect the brain?)**

- The appreciation of music is connected to a theory that suggests some of our ancestors, who were likely nocturnal, had to rely on their sense of hearing and smell for defence against predators.
- The acoustic cues that the human brain recognizes, for example, footsteps, travel through the ear and into the temporal lobe, which parses the soundscape, identifies sounds, and tags their components as familiar or unfamiliar.
- The salience of these sounds – whether humans respond to them emotionally and motivationally – influences the Autonomic Nervous System (ANS). This system controls involuntary processes such as breathing and heart rate. The valence of the music, which signals whether the music feels positive, negative, or somewhere in between, influences the ANS, too. This is why our heart rate might spike up when we're listening to fast, accelerating music as compared to slow, calm, jazz music or lullabies.

**Specific topic: "How music affects different types of mental health issues and parts of the brain."**

- Music nearly lights up almost all parts of our brain – including the hippocampus and **amygdala**, which activate emotional responses to music through memory; the limbic system, which governs pleasure, motivation, and reward; and the body's motor system. This is why "it's easy to tap your feet or clap your hands to musical rhythms," says Andrew Budson, MD'93, chief of cognitive and behavioural neurology at the Veterans Affairs Boston Healthcare System. The brain's elaborate receptivity to music means that "lots of different things are going on simultaneously," Budson adds, so music "ends up being encoded as a rich experience."
- Studies show that music tends to light up, activate, or stimulate the entire brain, including the following:
  - Auditory Cortex (Temporal Lobe)
  - Limbic System
    - → Amygdala
    - → Hippocampi
  - Reward System: areas such as the nucleus accumbens and ventral striatum.

    - Motor Cortex and Cerebellum
    - Prefrontal Cortex and,
    - Broca's and Wernicke's areas

- One research study held in 2019 even found that college students who listened to classical music every day for two months had decreasing levels of depression and anxiety.
- Another 2016 study looked at the connection between music and anxiety by studying people who have a fear of heights. Participants were put in a virtual reality simulation of riding up nine floors in an elevator. One group listened to music during the experiment, and the other didn't. The researchers found that those who listened to music recovered faster from the stress of the experience than those who didn't. And many studies suggest that listening to music can lower stress hormones as well as blood pressure and heart rate (both spike when you're stressed).

**How does this present a more viable solution to traditional therapy?**

- Music therapy is a technique that is already used in therapy, but is very underused. This type of therapy is becoming more common every year, but few people actually know about it.
- Music can be a better alternative to expression; music can be a non-verbal expression for people who find it hard to express themselves.
- Music is also a great tool for people who need to emotionally regulate and stabilize their mood. This can be a good alternative to traditional therapy for those who are overwhelmed by it.
- A study shows that music therapy usually has higher rates of success in treating depression, anxiety, and even neurological disorders, such as regaining body integrity after a stroke episode.
- Music therapy is easier and doesn't involve the hassle of getting ready, travelling, and waiting to meet a therapist. These activities can induce more anxiety and dark thoughts in the brains of people with these mental health issues, especially if it's their first time.
- Music therapy can be done over video call and is thus accessible to everyone, no matter what conditions they might be in. It also reduces the anxiety of your information being leaked to other people when you share information with your therapist.

**General topic**

**(How does music affect the brain?)**

Music exerts a powerful influence on the brain as it simultaneously engages several regions of the brain. The auditory cortex is responsible for processing music sounds when an individual listens to music, and the limbic system regulates the emotional response. Therefore, music is capable of evoking happiness, sadness, or tranquillity in a person. Moreover, music is related to memory through the hippocampus, which is why a certain song may evoke a memory vividly. Besides that, the brain's motor areas react to rhythm, which is why people are likely to tap their feet or get up and dance when music is played.

Music induces the brain to release dopamine, which is a neurotransmitter connected with pleasure and motivation, and it alleviates stress by decreasing cortisol levels. Owing to the power of music, it is frequently employed to elevate concentration, aid learning, and maintain emotional health. This way, music becomes a significant factor in the brain's functioning.

**Specific topic: How does music affect different types of mental health issues and parts of the brain?**

Music has been found to be able to address various types of mental health issues by targeting different brain areas associated with emotion, memory and stress regulation. First of all, the limbic system, more specifically the amygdala and hippocampus, is closely related to emotional and memory processing, which can be beneficial for mitigating any anxiety and depression symptoms by making the person more relaxed and encouraging positive emotions.

Besides that, music acts as a stimulant for the prefrontal cortex, which, among other things, oversees concentration and emotional regulation, thus making it a powerful tool for someone who is trying to control their mood and the presence of intrusive thoughts. Certain types of music can help in different ways. For instance, slow music can reduce cortisol levels and decelerate heartbeat in an individual with stress-related disorders, whereas fast, paced music could up the dopamine release, thus enhancing one's drive and mood.

Moreover, Music therapy has proven to be an effective way to assist people with post, traumatic stress disorder (PTSD), autism, and Alzheimer's disease, among other conditions, to some extent, along the lines of these cases the artists have been able to process the emotions, overcome the communication gap and even recollect the memories, thus unfolding the potential of music in the therapy of mental health as well as brain function.

**How does music help reduce symptoms of anxiety and depression?**

Music can be considered as a medicine to some extent for people with anxiety and depression disorders because it has the ability to change our brain chemistry, help in emotional regulation and also it can calm our stress response.

When you listen to your favourite music or something that you find relaxing, it activates your brain's reward center, which leads to the release of neurotransmitters like dopamine and serotonin. These chemical messengers are usually at very low levels in patients with depression.

Moreover, music decreases the activity of the amygdala, which is the part of the brain that controls fear and anxiety, and it also helps lower the levels of the stress hormone (cortisol), heart rate and blood pressure, which all play a role in moving the body out of the fight or flight stage.

Furthermore, by connecting the prefrontal cortex and the limbic system, music helps us to be able to face and healthily express our emotions, thus it can also break the pattern of intrusive negative thoughts that typically happen in both anxiety and depression.

In this way, music can give us an emotional outlet, some mental comfort and a lift in our spirits. Therefore, we can also say it is a very helpful tool for supporting a person with anxiety or depression.

**How does music help individuals who suffer from schizophrenia, or reduce symptoms?**

Music plays an important role in helping people with schizophrenia as it helps them regulate their emotions, lowers their stress level, and boosts their cognitive and social abilities. For example, simply listening to soothing or personally significant music can decrease anxiety and stress since it triggers the reduction of cortisol and the calming of hyperactivity in the limbic system, thus possibly lessening the severity of symptoms like agitation or paranoia.

Moreover, music stimulates the prefrontal cortex, which is responsible for attention, emotional control, and thought organization, functions that are often impaired in individuals with schizophrenia.

During music therapy, the patients, through making or listening to music, can be helped in expressing their feelings even without words, communicating better, and becoming socially more connected, that is the main reason why their feelings of loneliness decrease. Of course, music is not a substitute for medicines or other clinical treatments and, therefore, should be used only as a complementary tool, but it certainly can help in symptom management, in lifting the patients' spirits, and in making their everyday life more pleasant and fulfilling.

**How can music help individuals who have PTSD?**

Music offers various benefits to people suffering from PTSD, such as soothing the nervous system, facilitating emotional release and lessening the severity of trauma symptoms. A common characteristic of PTSD is an excessive stress response. Through mechanisms like lowering cortisol levels, decreasing heart rate and reducing hyperarousal, relaxing music can be a great aid for stress regulation. Besides, the amygdala and limbic system, which play a key role in fear and

emotional memory, are also impacted when individuals engage in music; thus, music can help patients feel less scared and more grounded. Furthermore, within the context of therapy, music can serve as a medium for expressing emotions that are too overpowering and thus difficult to verbalize; on the other hand, the use of familiar or loved songs can lead to feelings of security and control. Besides that, listening to music can be a distraction to thoughts of harm and flashbacks since it reduces attention.

**How can the type of music affect a person's mood?**

The kind of music one listens to has a great influence on the mood, particularly those with depression, anxiety, PTSD or schizophrenia. Slow and soothing music can be very effective in decreasing anxiety and stress because it relaxes the body and creates a feeling of safety that is very beneficial for people with PTSD. Cheerful tunes can uplift the mood and help with motivation in cases of depression by giving people the energy and emotional boost they need. Deeply moving or emotionally charged music might be a way for people to come to terms with the pain of their lives and realize that they are not alone, which is good for many mental health issues. Also, lyrics have a significant impact, as comforting or uplifting messages can help with emotional control, while exaggerated music may increase distress in some individuals. In general, making the right choice of music can be of great help in the management of symptoms as it facilitates emotional balance, relaxation, and mood stability.

**What part of the brain music activates:**

Music activates various parts of the brain at once, which is why it has such a strong effect on our mood and mental health. The first brain area to handle sound is the auditory cortex, whereas the emotional responses to music are mainly linked to the limbic system, which includes the amygdala and hippocampus that play a role in emotion and memory. Also, the prefrontal cortex, which is in charge of emotional regulation, attention, and decision making, is triggered and plays a part in music's impact on mood and stress levels.

Moreover, music can activate the brain's reward circuit that results in the secretion of dopamine, a neurotransmitter that is linked to pleasure and motivation. One study shows that music that calms the mind can quiet the amygdala in people with anxiety, thus decreasing their fear and stress reaction.

People with depression fall into the same category in a way that they might get their dopamine release increased, as well as activation of the emotional processing areas from music. Such processes can bring about a short-lived elevation in their mood.

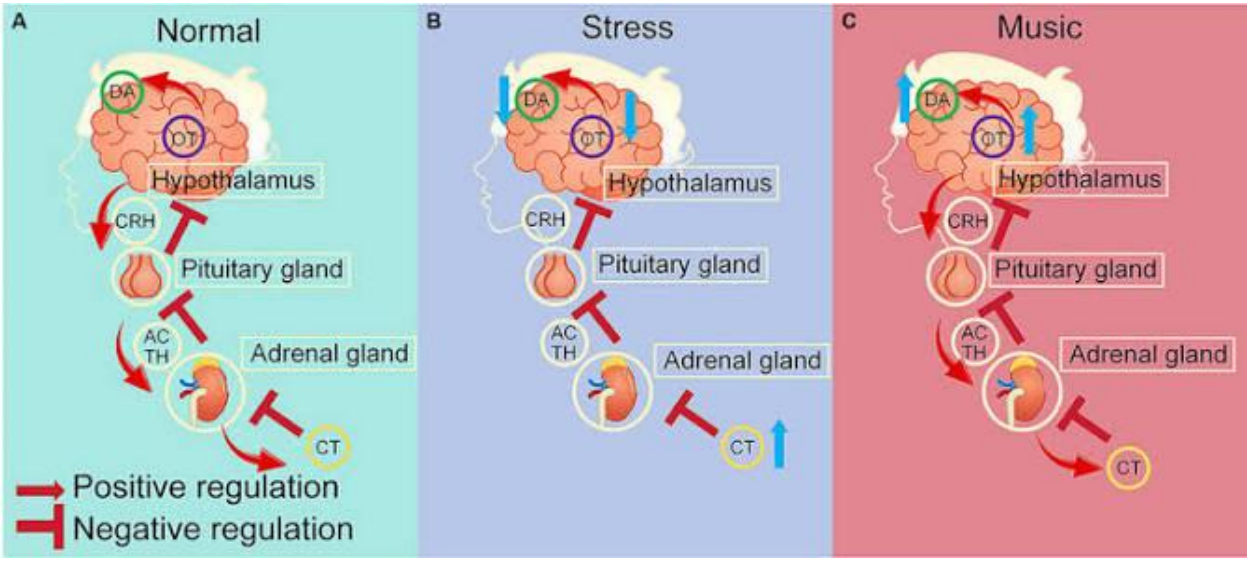
When it comes to post-traumatic stress disorder (PTSD), music can engage memory, related regions such as the hippocampus, which might be of help in emotional regulation, but certain parts of music can also trigger traumatic memories. For people with schizophrenia, research shows that

music can affect the neurons tightly connected with emotional expression and attention, and through this, it may help the individual's mood and social functioning. However, brain responses to music might differ from those of healthy subjects.

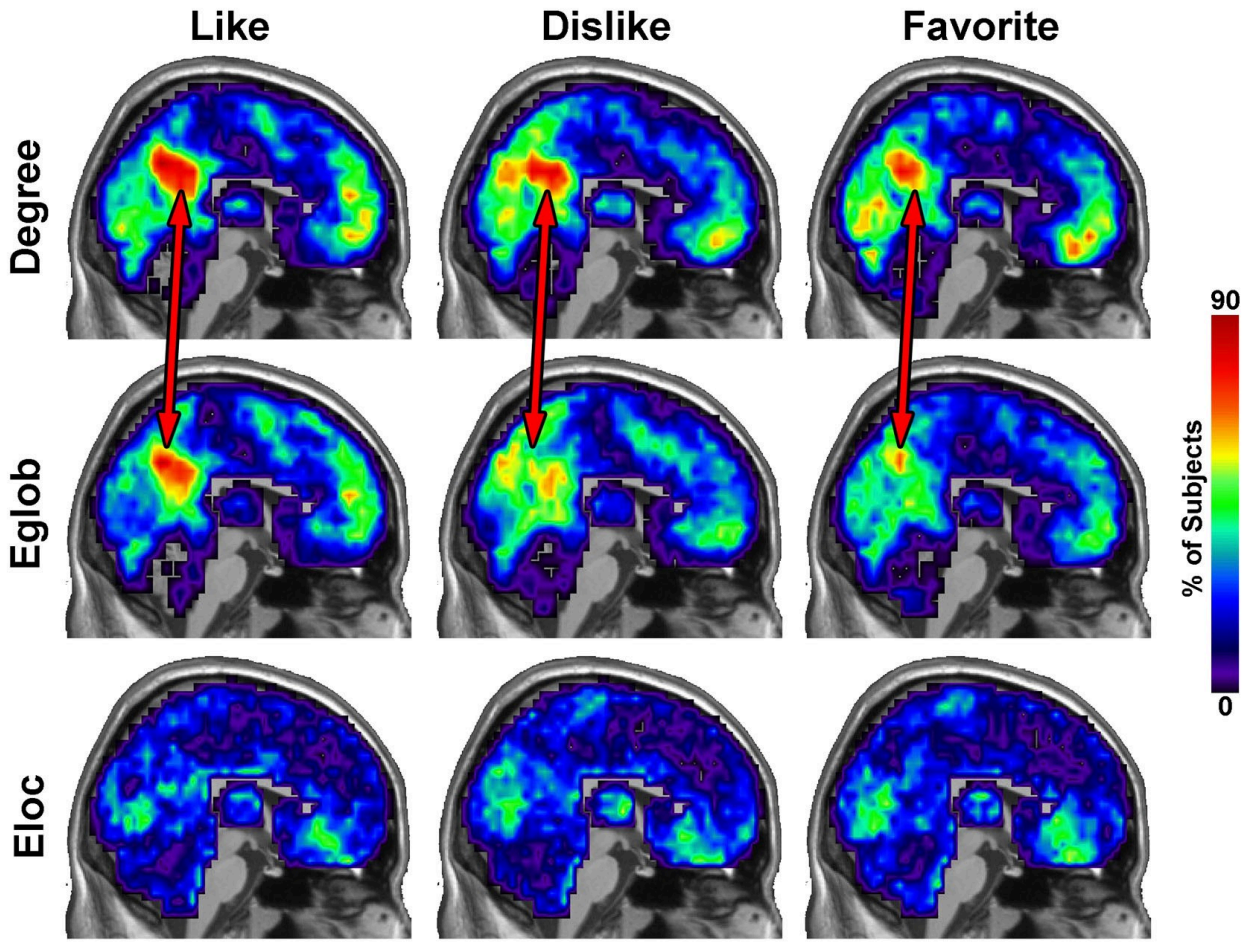
# Resources

1. https://magazine.hms.harvard.edu/articles/how-music-resonates-brain **This is a study on how the brain reacts to music, why it reacts that way, and why we feel intense emotions while listening to music.**
2. **https://pmc.ncbi.nlm.nih.gov/articles/PMC10765015/ Another study**
3. Cognitive Crescendo: How Music Shapes the Brain's Structure and Function - PMC
4. Your Brain on Music: The Sound System Between Your Ears
5. The transformative power of music: Insights into neuroplasticity, health, and disease - ScienceDirect
6. Music and the Brain | Harvard Medical School
7. Your Brain on Music - University of Central Florida
8. The effects of playing music on mental health outcomes | Scientific Reports
9. How Music Can Improve Your Mental Health - The Jed Foundation.
10. Influence of Music on Anxiety Induced by Fear of Heights in Virtual Reality
11. https://www.tandfonline.com/doi/epdf/10.1080/17437199.2019.1627897?needAccess=true -a PDF with causes and reasons for anxiety and the like.
12. Effects of music interventions on stress-related outcomes: a systematic review and two meta-analyses
13. The Effect of Classical Music on Anxiety and Well-Being of University Students
14. How Music Can Improve Your Mental Health
15. Effects of Music on Symptoms of Schizophrenia - Psychiatry Advisor
    Research on the effects of music on PTSD
16. Music interventions for posttraumatic stress disorder: A systematic review - ScienceDirect
17. Music Therapy for PTSD
18. Music Therapy for Posttraumatic Stress in Adults: A Theoretical Review - PMC
19. Psychiatry.org - The Transformative Power of Music in Mental Well-Being

# Pictures in our tri-fold




Pictures of the brain in different circumstances




**Title**: The brain, when people listen to different types of music.

Things to know about the image:
*What You're Looking At*
This image shows brain scans (likely fMRI data) of people listening to music under different conditions.

Across the top, you see:

- Like
- Dislike
- Favorite

So each column represents how the brain responds when someone listens to:

- Music they like
- Music they dislike
- Their favorite music

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## The Colour Scale (Right Side)

On the right, there's a colour bar labelled:

"% of Subjects"

This means:

- Red/yellow = a high percentage of participants showed activation in that brain area
- Blue/purple = low activation

So warmer colours = stronger or more consistent brain activity across people.

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## Now Let's Talk About the Y-Axis Labels

On the left side, you see:

- Degree
- Eglob
- Eloc

These are not body parts. They're types of brain connectivity measurements.

They describe *how connected different brain regions are while listening to music.*

Here's what each likely means:

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### 1️⃣ Degree

"Degree" refers to how many connections a specific brain region has with other regions.

Think of it like:
If your brain were a social network,
degree = how many "friends" that brain area has.

Higher degree = that area is communicating with lots of other regions.

In this image:
When people listen to music they like or love, certain regions (especially reward/emotion areas) show higher connectivity.

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### 2️⃣ Eglob (Global Efficiency)

This stands for Global Efficiency.

It measures:
How efficiently information moves across the entire brain network.

In simple terms:
How smoothly do different brain regions talk to each other overall?

Higher global efficiency means:
The brain is working in a more coordinated, integrated way.

The music people enjoy seems to increase global communication compared to disliked music.

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### 3️⃣ Eloc (Local Efficiency)

This stands for Local Efficiency.

It measures:
How well small clusters of nearby brain regions communicate with each other.

Think of it like:
Not the whole city communicating —
but neighborhoods talking within themselves.

Local efficiency shows tight coordination in specific brain areas.

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## What the Red Arrows Are Showing

The arrows are highlighting a region that lights up strongly in:

- Like
- Favorite

But less so in Dislike.

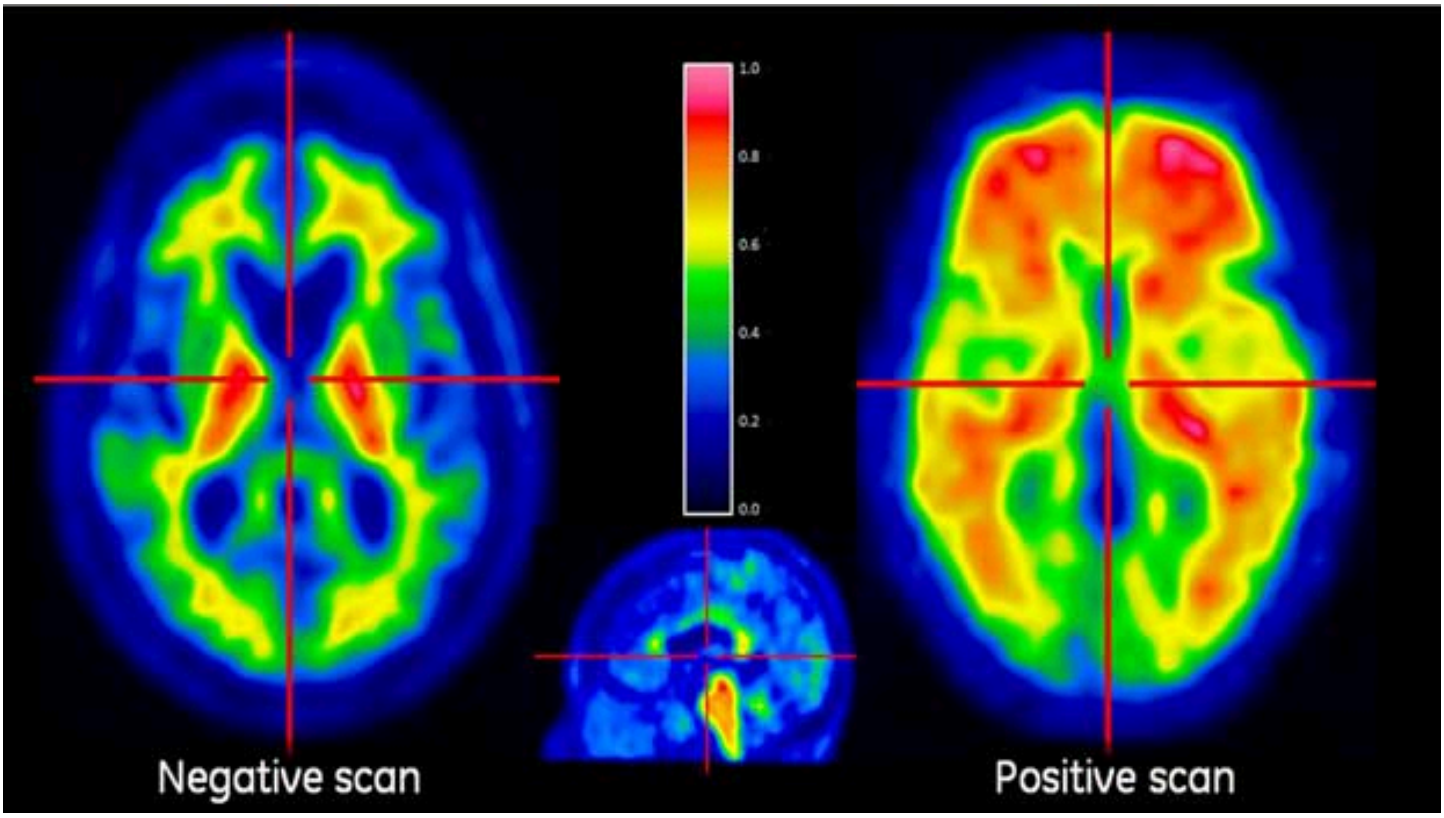
That region is likely part of:

- The reward system (like the nucleus accumbens)

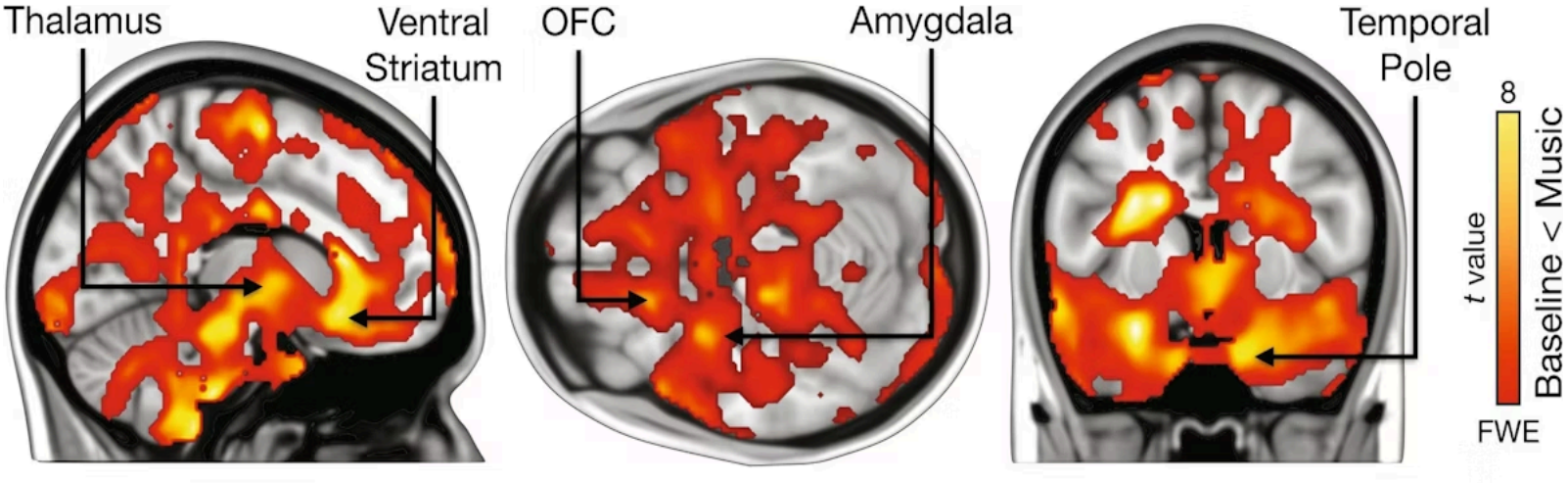
- Or emotional processing areas (like parts of the prefrontal cortex)

Basically:

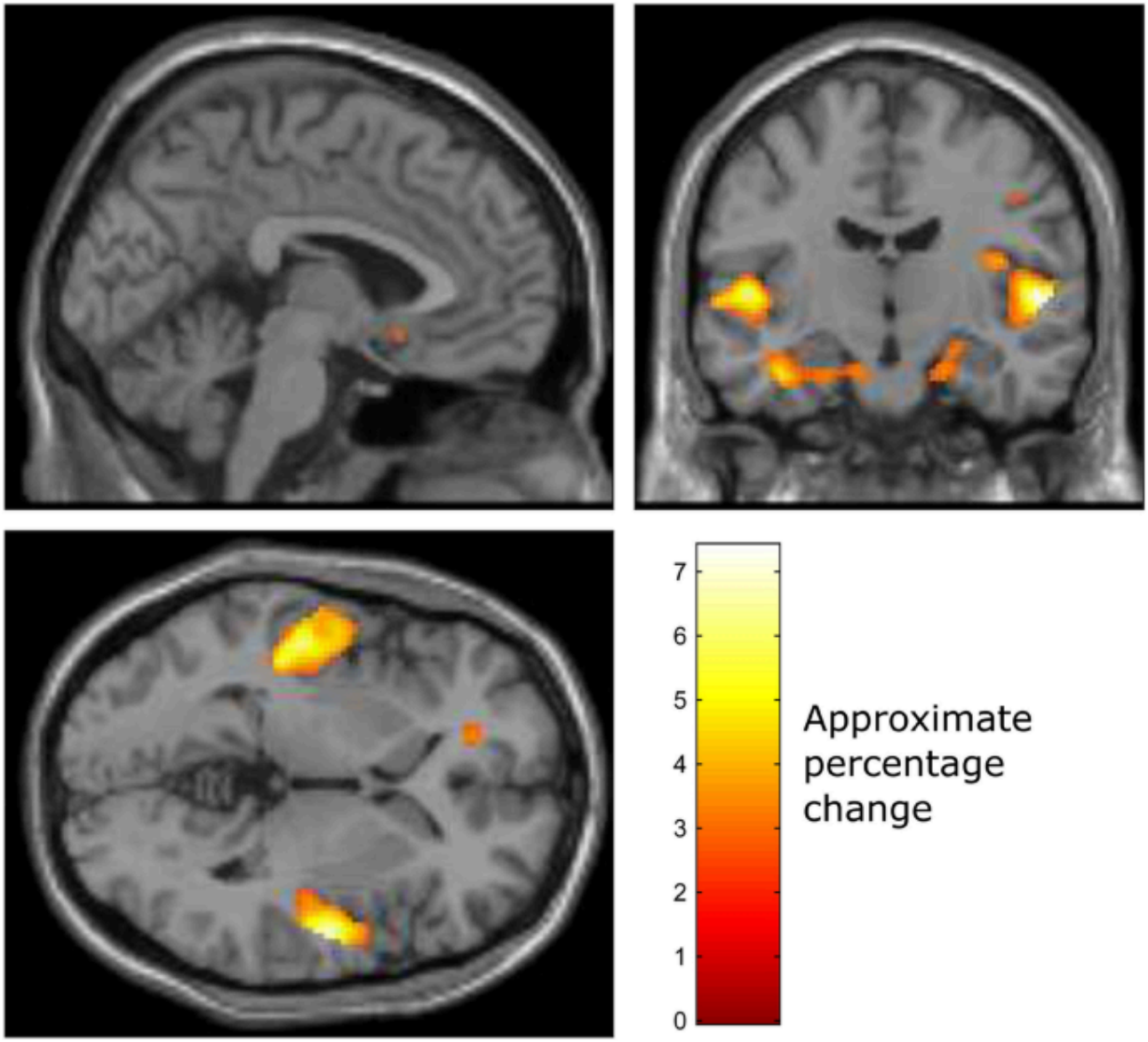
When you hear music you love,  your brain's reward and emotion circuits become more connected.




The brain in a normal setting vs. the brain when listening to music




The activity of different regions of the brain when listening to music


7
6
5
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3
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1
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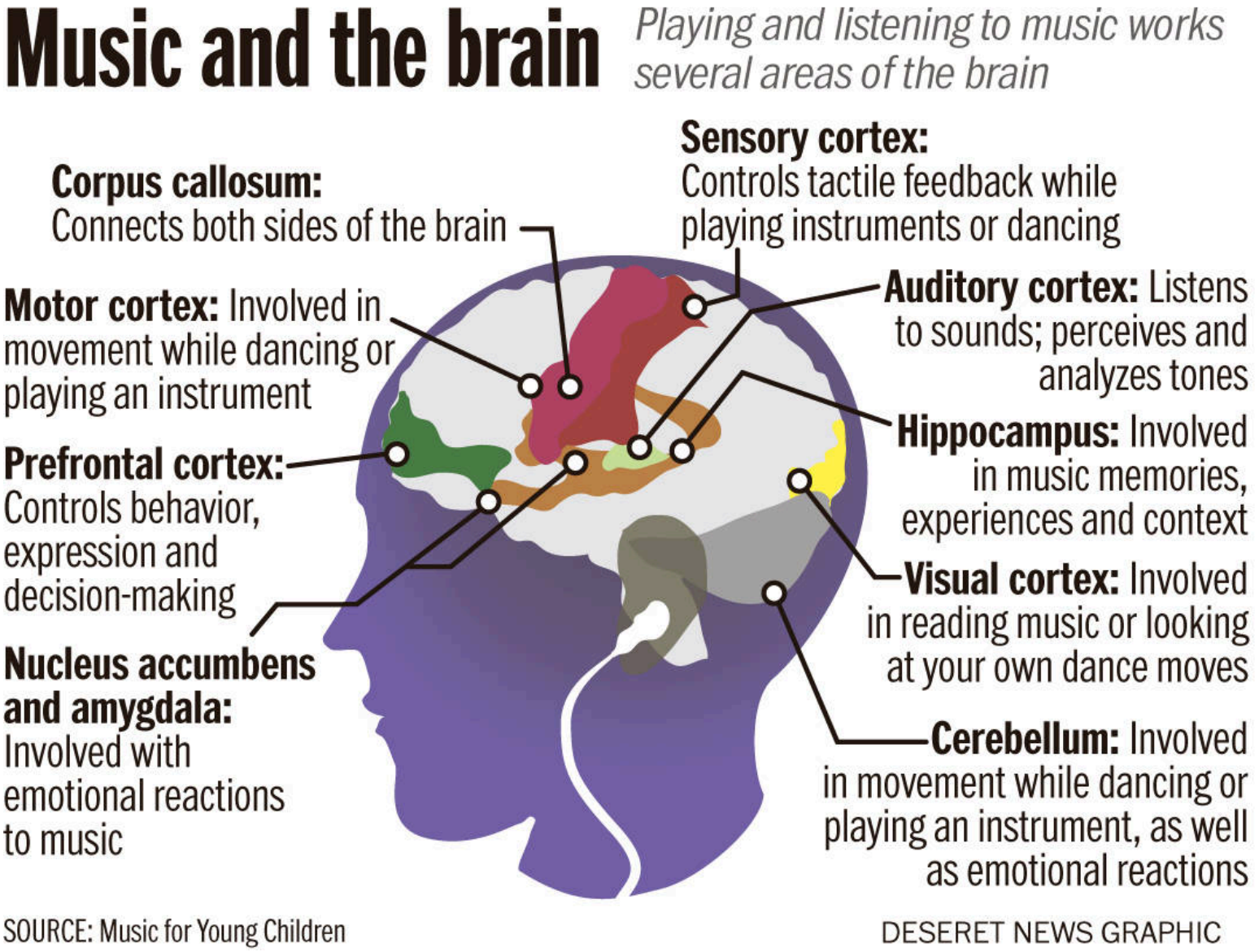
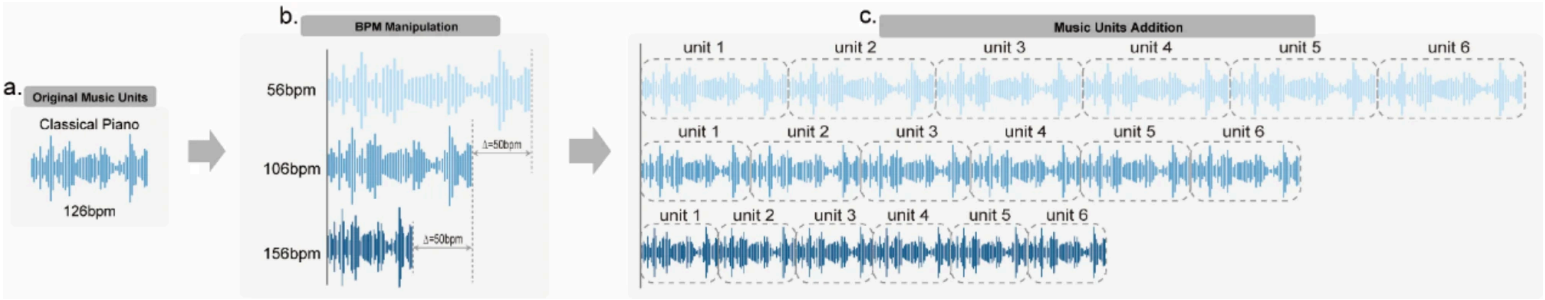
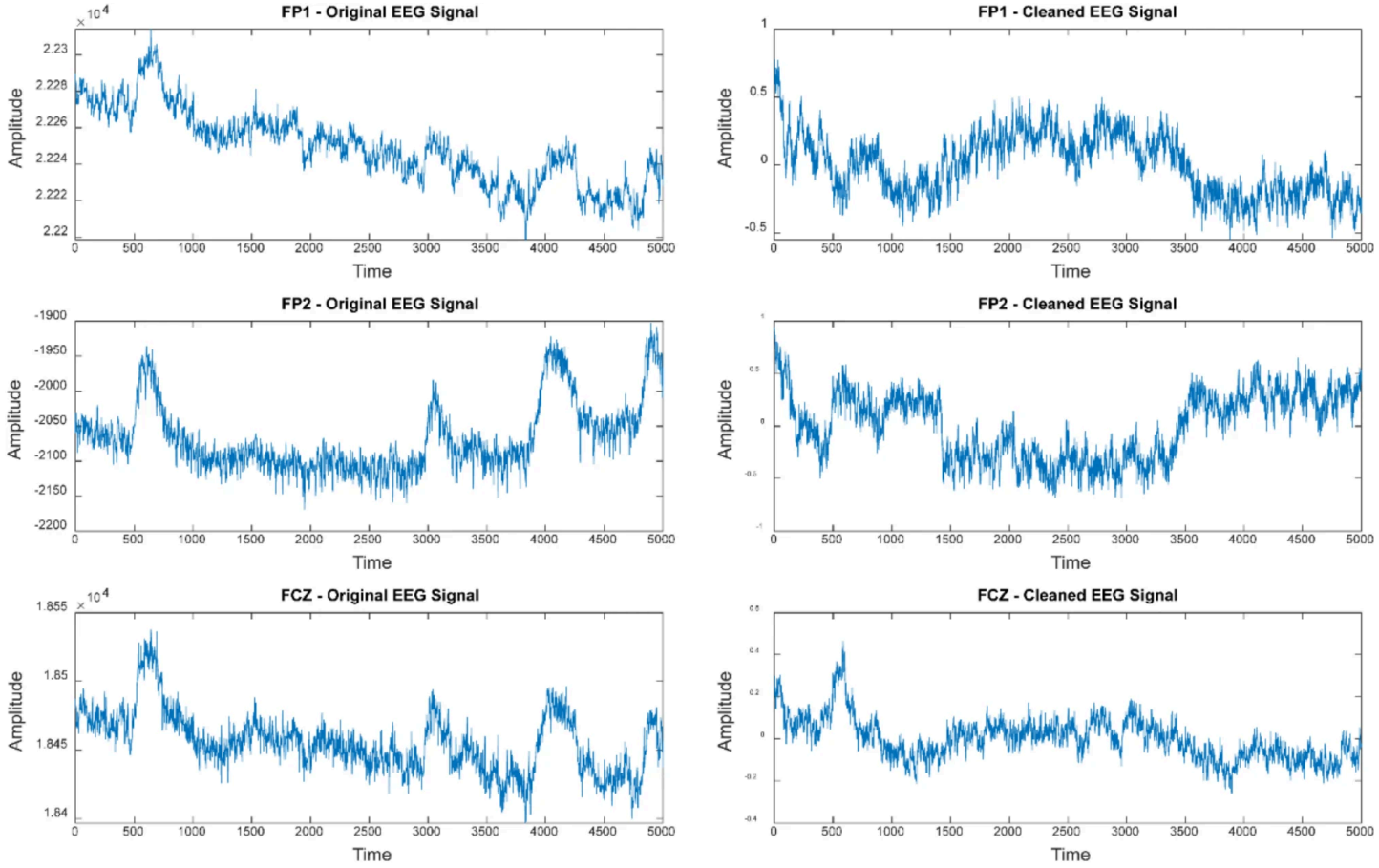
Approximate
percentage
change




How each of the regions of the brain is involved when we are listening to music
OR
Involvement of different regions of the brain when listening to music.

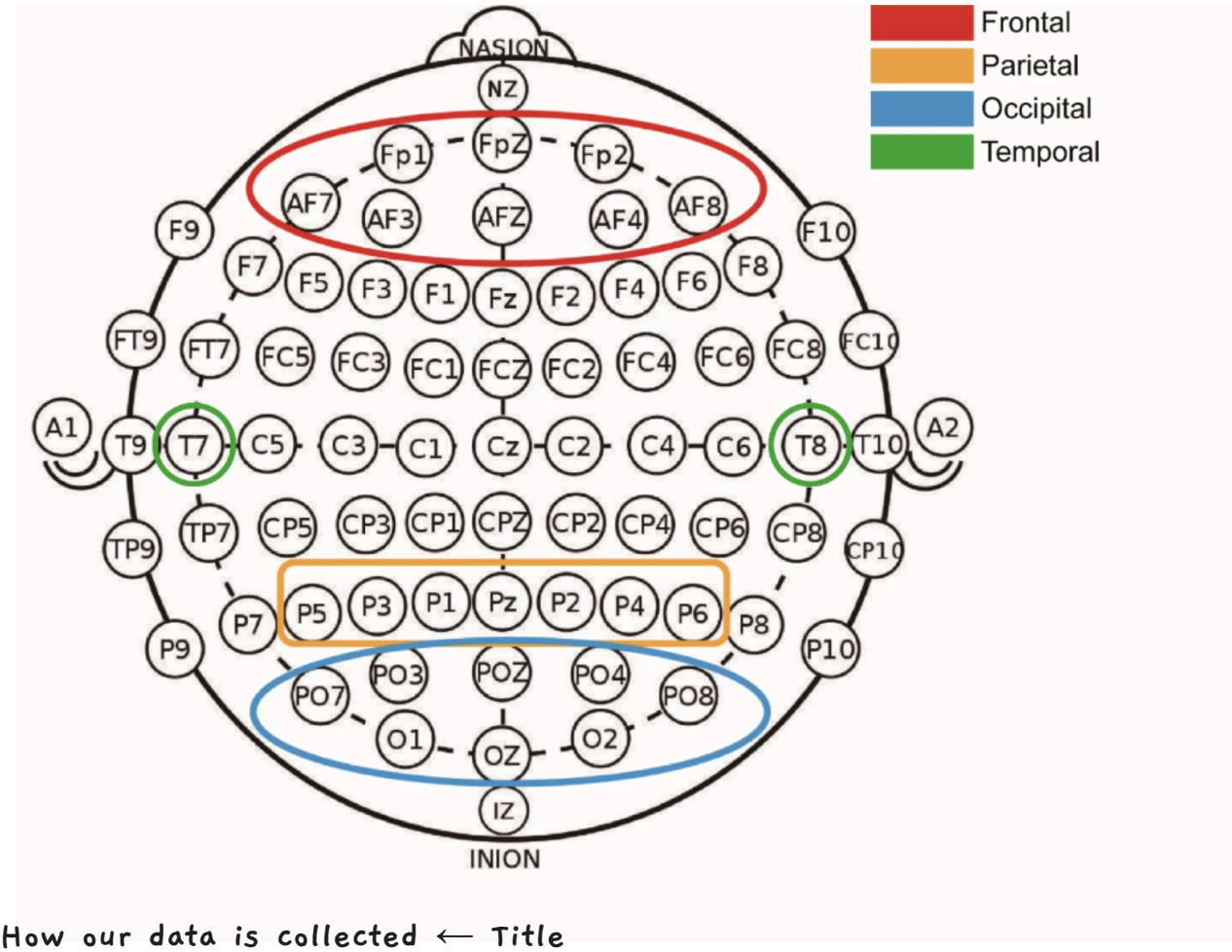



Brain activity when listening to different rhythms in music.




## Description of the picture:

This shows how the activity of the brain is computed and understood by scientists.




How our data is collected ← Title

## Things that should be included in the final product

**I. Research Question (10 pts)**

___ clear and focused purpose

___ identifies contribution to field of study

___ testable using scientific methods

**II. Design and Methodology (15 pts)**

___ well designed plan and data collection methods

___ variables and controls defined, appropriate and complete

**III. Execution: Data Collection, Analysis and Interpretation (20 pts)**

___ systematic data collection and analysis

___ reproducibility of results

___ appropriate application of mathematical and statistical methods

___ sufficient data collected to support interpretation and conclusions

**IV. Creativity & Potential Impact (20 pts)**

___ project demonstrates significant creativity in one or more of the above criteria

___ project has impact or potential impact in its field and/or in technology, economy, environment or society

**V. Presentation (35 pts)**

a. Poster  10 pts)

___ logical organization of material

___ clarity of graphics and legends

___ supporting documentation displayed

b. Interview (25 pts)

___ clear, concise, thoughtful responses to questions

___ understanding of basic science relevant to project

___ understanding interpretation and limitations of results and conclusions

___ degree of independence in conducting project

___ recognition of potential impact in science, society and/or economics

___ quality of ideas for further research

___ for team projects, contributions to and understanding of project by all members

## Judging Criteria for Engineering Projects

**I. Research Problem (10 pts)**

___ description of a practical need or problem to be solved

___ definition of criteria for proposed solution

___ explanation of constraints

**II.  Design and Methodology (15 pts)**

___ exploration of alternatives to answer need or problem

___ identification of a solution

___ development of a prototype/model

**III. Execution: Construction and Testing (20 pts)**

___ prototype demonstrates intended design

___ prototype has been tested in multiple conditions/trials

___ prototype demonstrates engineering skill and completeness

**IV. Creativity & Potential Impact (20 pts)**

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