

## **DATA 6550 - Group 4**

### **Testing the accuracy of AI for the field of Neuroanthropology**

#### **1. Introduction**

In the era of big data, many have constructed AI (Artificial Intelligence) models for the purposes of education. Recently, AI developments have led to the rise of LLMs (Large Language Models), which have seen many applications, both commercial and noncommercial. In spite of these new developments, it is evident that, despite the pace of improvement, AI LLM models still have limits when compared to field experts.

Here, we will discuss the emerging field of Neuroanthropology. In spite of new developments in science, not much is known about the field of neuroanthropology. Neuroanthropology is an interdisciplinary field that involves the usage of biology, psychology, and anthropology. Please note that neuroscience itself is the intersection of biology and psychology, and also branches into neurobiology and neuropsychology. Neurobiology focuses on the cellular and molecular aspects of the nervous system (including the brain), and neuropsychology focuses on the behavioral and cognitive aspects of the brain. The intersection of neuroscience with anthropology sits at anthropology's subfields, bio-anthropology and medical anthropology, where bioanthropology focuses more on the physical and historical aspects of humans and hominid ancestors, whereas medical anthropology focuses more on the cross-cultural aspects of healthcare for groups of individuals.

We will test the knowledge of AI LLM on the subject matter of neuroanthropology. To do so, we will focus on knowledge of the subfields of neuroanthropology, including the sub-subfields and compare them to established scientific resources. As mentioned earlier, the primary subfields are biology, psychology, and anthropology. Here, biology's subfields will include neurobiology and part of bio-anthropology (as this subfield is sometimes labeled under natural science). Psychology's subfields will include neuropsychology and clinical psychology. Anthropology's subfields will include cultural anthropology, medical anthropology and part of bioanthropology. We will then discuss potential applications in both education and business for the usage of AI.

#### **2.1. Biology**

Biology itself is defined as the study of life. As human beings are living organisms, biology is foundational for understanding humans. As such, the field of neuroscience originally consisted of only neurobiology. After the field developed enough, neurobiology was then applied to the social sciences, which led to the rise of modern neuroscience. On its own, neurobiology is focused on the neuroanatomy and neurophysiology, or the physical structure and function, of the brain and overall nervous system (which includes the spinal cord among other nerves). For this section, we decided to ask Microsoft copilot questions about varying topics of the biological side of neuroanthropology.

#### **Question 1: how are human brains compared to brains of neanderthals**

Copilot answer: “Neanderthals actually had **larger brains** than modern humans, but size isn’t everything when it comes to intelligence. The key difference lies in **brain organization**. Neanderthals had **larger visual processing areas**, likely to help them survive in low-light environments. Meanwhile, modern humans developed a gene mutation—**TKTL1**—that allowed for more neurons in the neocortex, the part of the brain responsible for higher cognitive functions. This may have given Homo sapiens an edge in problem-solving and adaptability.

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Analysis: CoPilot cited two sources for this:

<https://science.howstuffworks.com/life/inside-the-mind/human-brain/neanderthal-bigger-brains-humans.htm>

<https://www.smithsonianmag.com/smart-news/whats-the-difference-between-a-human-and-neanderthal-brain-180980736/>

Overall, the information provided by the AI model is correct. Neanderthals did have larger brains than humans, and most of the size difference was because of vision. What the model didn’t say was that Neanderthal skulls also had larger eye sockets, which suggests they needed larger parts of the occipital (vision) portion of the brain. In addition, what isn’t mentioned is that humans also have larger cerebellums than Neanderthals, which may have helped humans in terms of higher cognition including language processing. Other sources clarify that an amino acid substitution had helped cause the gene mutation that produced more frontal lobe neurons in humans.

## **Question 2 : describe the neurobiology of the fight or flight response**

The **fight-or-flight response** is an automatic physiological reaction to perceived threats, governed by the **autonomic nervous system (ANS)** and primarily driven by the **sympathetic nervous system (SNS)**. Here’s a breakdown of its neurobiology:

1. **Perception of Danger** – When the brain detects a potential threat, the **amygdala**, a key region for processing fear, becomes highly active. It sends distress signals to the **hypothalamus**, which acts as the command center for the autonomic response.
2. **Activation of the SNS** – The hypothalamus signals the **adrenal medulla**, prompting it to release **adrenaline (epinephrine)** and **noradrenaline (norepinephrine)** into the bloodstream. This surge increases **heart rate**, **blood pressure**, and **oxygen intake**, preparing the body to take action.
3. **Hormonal Cascade via the HPA Axis** – If the threat persists, the **hypothalamic-pituitary-adrenal (HPA) axis** is engaged. The hypothalamus releases **corticotropin-releasing hormone (CRH)**, which stimulates the **pituitary gland** to

release **adrenocorticotrophic hormone (ACTH)**. ACTH then triggers the **adrenal cortex** to produce **cortisol**, helping sustain heightened alertness and energy.

4. **Physical Effects** – Blood is redirected from non-essential processes (such as digestion) toward muscles to enhance strength and reaction time. Pupils dilate for better vision, and glucose is released into the bloodstream for extra energy.
5. **Returning to Baseline** – Once the threat is gone, the **parasympathetic nervous system (PNS)** takes over, reducing heart rate and restoring the body to a relaxed state.

This response evolved to help humans and animals survive dangerous situations, but in modern life, it can be triggered by stress rather than physical threats. Chronic activation, especially due to long-term stress, can have negative health effects over time.

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Analysis: CoPilot does give a sufficient overview of the fight or flight response system. It explains the fight-or-flight response in a way that is approachable for beginners to the topic. However, it does oversimplify and skip details. For example, what it didn't mention was the structure and classification of the nervous system. Note that the overall nervous system is made of the Central Nervous System (which includes the brain and spinal cord), and the Peripheral Nervous System (or PNS, for everything else). The PNS then is divided into the Somatic Nervous System (for Voluntary Movements) and the Autonomic Nervous System (for involuntary movements, which includes the fight-or-flight response).

In addition, while CoPilot does mention that the Sympathetic Nervous System excites the body (to start the fight-or-flight response) and the Parasympathetic Nervous System calms the body, it doesn't mention that they are both subbranches of the Autonomic Nervous System. Overall, this question has shown that the AI model is good for introductory learning, but that more established resources are needed as well.

### **Question 3: what is the neuroscience of language development**

CoPilot Answer:

Language development is a fascinating process shaped by the brain's intricate neural networks. Neuroscience research has identified key brain regions involved in language acquisition and processing:

1. **Broca's Area** – Located in the **left frontal lobe**, this region is crucial for speech production and grammatical processing.
2. **Wernicke's Area** – Found in the **left temporal lobe**, it plays a major role in understanding spoken and written language.
3. **The Arcuate Fasciculus** – A bundle of nerve fibers connecting Broca's and Wernicke's areas, enabling fluent communication between speech production and comprehension.

4. **Subcortical Structures** – The **basal ganglia** and **cerebellum** contribute to language learning by refining speech motor control and cognitive processing.
5. **Neuroplasticity** – The brain's ability to reorganize itself allows children to acquire language rapidly, and even enables recovery from language impairments after brain injuries.

Recent studies emphasize the **network perspective** of language processing, showing that multiple brain regions work together dynamically. Neuroscientists also explore how early childhood experiences shape language development, influencing cognitive and social abilities<sup>2</sup>.

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Analysis: 2 sources cited by Copilot:

<https://oecs.mit.edu/pub/3bgjh908/release/1>

<https://solportal.ibe-unesco.org/articles/applying-the-neuroscience-of-language-to-the-training-of-early-childhood-educators/>

Overall, the AI model gives a correct overview of language development in the brain. The Broca area does speech production, whereas Wernicke's area does speech recognition. Impressively, Copilot also mentions the regions of the brain that Broca's Area (frontal lobe) and Wernicke's area (temporal lobe) are in. Note that the frontal lobe is responsible for reasoning, and the temporal lobe is for memory storage (keeping information for the meaning of words is important for recognizing when and how the words are used). Sources also agree that the arcuate Fasciculus also helps connect Broca's to Wernicke's area. However, scientists are uncertain as to how much the basal ganglia and cerebellum help with language development. While damage to those regions of the brain impair the ability to understand language, it is yet clear what their functions for language are. Interestingly, it mentions neuroplasticity in children, but not why children are better at learning language than adults. This is because children have more synapses (connections between neurons) which let the neurons work in synergy for learning better. As one ages, more unused synapses are “pruned” (rendered nonfunctional).

## 2.2. Psychology

Psychology, the scientific study of the human mind and its behavior, plays a central role in the field of neuroanthropology. Psychology provides a theoretical foundation for understanding human behavior, cognitive processes, and factors that influence our thoughts, feelings and actions - all of which are heavily shaped by biological and cultural factors. Within psychology, the subfield of neuropsychology studies the relationship between the brain and behavior. Neuroanthropology builds on this by exploring how neurological systems are shaped by cultural practices, experiences and environments. We will be asking our neuroanthropology educational/consulting company's chat bot (Chat GPT) *detailed medical queries* to test its specialized knowledge and observe how accurate and reliable its responses to online users are.

**Question 1. I have anxiety — can you tell me which brain region causes it and how to fix it naturally?**

AI Chatbot: The chatbot states that anxiety involves several brain regions working together like the Amygdala, the Prefrontal Cortex, and the Hippocampus. It recommends natural ways to help regulate anxiety using brain based strategies. It states that studies show how mindfulness and meditation strengthen the prefrontal cortex and calm the amygdala, how regular exercise promotes neurogenesis (new brain cell growth) in the hippocampus and releases calming neurotransmitters like serotonin, and how a healthy sleep routine repairs emotional regulation networks. It also makes an important note that everyone's brain and culture shape anxiety differently. What works for an individual depends on personal, genetic, and cultural factors (Chat GPT).

**Analysis:** When asked for the regions of the brain that are responsible for anxiety and how to fix it naturally, the AI chatbot correctly identifies the key areas of the brain and offers science backed natural strategies such as meditation, sleep and exercise. While the response is broadly accurate, it simplifies a complex psychological condition and implies that anxiety can be fixed by lifestyle changes without noting possible medical treatment. According to the 'Science of Anxiety' Infographic by Northwestern Medicine, the Limbic System is the emotional nervous system that is responsible for the majority of emotional processing of the brain. This system includes the amygdala, hippocampus, hypothalamus and thalamus, some of which the chatbot did not mention. Northwestern medicine also states that there are several types of anxiety disorders so it is important to make time for mental health as 'there's more than meets the eye when it comes to the science behind anxiety', which the chatbot never disclosed or suggested (nm.org).

**Question 2. If I meditate for 2 hours a day, can I permanently change my amygdala and stop being afraid?**

AI Chatbot: Meditation can *shrink* the amygdala, calm fear responses, and build emotional resilience. Two hours a day could create very powerful, *lasting change*, especially if paired with a healthy lifestyle and supportive environment. But the brain always stays flexible — it's an ongoing relationship with yourself, not a "fix once and done" (Chat GPT).

**Analysis:** The chatbox's response to the question reflects a mix of accurate neuroscience and oversimplification. While research shows that meditation can reduce amygdala activity, the phrase 'powerful, lasting change' overstates the permanence of these effects and the phrase 'shrinking the amygdala' could be misleading to users. A report on mindfulness meditation by the National Institute of Health (NIH) mentions the 'resilience' of stress and fear, rather than lasting changes in how the AI chatbot advises its users (nih.gov).

**Question 3. I'm worried about my kid — he has trouble speaking — can you tell me which neurotransmitter he's missing?**

AI Chatbot: Speaking is a complex skill that depends on *several* neurotransmitters, not just one. The major ones connected to speech are Dopamine, Glutamate, GABA, and Acetylcholine. Depending on what's happening, your child might have an imbalance — too little dopamine, too much glutamate, or other variations. However, speech issues are almost *never* caused by a single missing neurotransmitter. They're usually the result of a combination of brain development, genetics, environment, and social experiences. The chatbot reminds the user that the brain is very malleable during childhood and that it is easy to strengthen speech areas through therapy, emotional bonding, games, and even nutrition. It recommends the user to try going to a speech-language pathologist, a developmental pediatrician, or a neurologist for personalized help. It even offered some brain-friendly at home activities to encourage speech growth (Chat GPT).

**Analysis:** The AI chatbot's response to neurotransmitters and speech difficulty in children appropriately avoids oversimplification and a fixed answer or explanation. It correctly discusses that speech relies on multiple neurotransmitters like Dopamine, Glutamate, GABA, and Acetylcholine, and that speech issues are rarely due to a 'missing' neurotransmitter, which was stated in the AI response. Although it suggests a few at home exercises, it emphasizes the flexibility of the youth brain and avoids over evaluation without seeing a medical professional or being diagnosed.

Overall, it is a bit risky to have an AI chatbot give medical advice or responses on such complex psychological questions. It should always avoid the oversimplification of complex topics and suggest seeing medical professionals, as receiving online medical advice could be risky and cause legal concerns for the company.

### 2.3. Anthropology

AI understanding on Anthropology topic is analysed using Gemini 2.0. Below are the responses to queries asked.

#### a) Neuroscience, Anthropology vs neuroscience, anthropology, and is anthropology neuroscience?

**Neuroscience** is the scientific study of the nervous system, including the brain, spinal cord, and nerves. It's an interdisciplinary field that seeks to understand the nervous system's structure, function, development, and disorders at all levels, from molecules to behavior and cognition. By integrating various scientific disciplines, neuroscience aims to unravel how the nervous system works and to develop treatments for neurological and psychiatric conditions.

Anthropology broadly studies human societies, cultures, and biology using qualitative methods to understand the human condition holistically and comparatively. Neuroscience, on the other hand, focuses on the nervous system, particularly the brain, using quantitative methods to understand the biological basis of behavior and cognition. While distinct, these fields are increasingly converging in areas like neuroanthropology and cultural neuroscience to explore the complex interplay between culture, brain, and human experience. Anthropology provides

context, while neuroscience offers biological mechanisms, leading to a richer understanding of humanity.

**Neuroanthropology** is an interdisciplinary field that integrates neuroscience and anthropology to study the dynamic relationship between culture and the brain. It aims to understand how culture shapes the brain's development, structure, and function, and conversely, how the brain influences the emergence and evolution of cultural practices. It emphasizes studying "brains in the wild" – understanding neural processes within their real-world cultural contexts.

**b) Discuss the field of anthropology and how it (and subfields like bioanthropology and cultural medical anthropology) relates to neuroanthropology**

When asked the above questions, Gemini was quite elaborate discussing the definition of anthropology, subfields, how it relates with anthropology and cultural medical anthropology. The statement is quite lengthy. The AI was asked to summarize and below is the response.

“Anthropology, the holistic study of humankind, provides the foundational framework for neuroanthropology. Cultural anthropology offers the concept of culture, ethnographic methods, and cross-cultural comparison. Biological anthropology contributes insights into human evolution, the biocultural perspective, and human variation. Cultural medical anthropology examines how culture shapes health, illness, and healing. Neuroanthropology integrates these anthropological perspectives with neuroscience to understand the dynamic interplay between culture and the brain, providing a richer, context-aware understanding of human thought and behavior.”

**c) Refer to biases in data science, compare the American, European, Asian and African cultures as sources of data biases.**

- **American Culture:** Often emphasizes individualism and direct communication. Data scientists might lean towards collecting individual-centric data and interpreting results in a straightforward, potentially less context-dependent manner. There might be a stronger emphasis on efficiency and scalability in data collection.
- **European Culture:** Tends to value privacy and data protection (e.g., GDPR). Data scientists might be more attuned to ethical considerations around data collection and usage, prioritizing anonymization and user consent. There could be a greater emphasis on transparency and explainability of models.
- **Asian Cultures:** Many Asian cultures (e.g., East Asian) can emphasize collectivism, harmony, and indirect communication. Data scientists might be more inclined to consider group-level patterns and contextual factors in their analysis. Interpretation of data, especially related to social behavior, might be more nuanced and indirect.
- **African Cultures:** With immense diversity, many African cultures emphasize community and oral tradition. Data collection might require more culturally sensitive

approaches, prioritizing community engagement and understanding local contexts. The interpretation of data might heavily rely on qualitative insights and local knowledge.

**d) Does the red color in charts and graphs as used by data scientists in visualization mean the same across America, Europe, Asia and Africa?**

The Gemini responded with an elaborate breakdown citing examples about the red color. Below is the response when asked to summarize it.

“The meaning of red in data visualizations (charts and graphs) is not universal. While often signifying negative values or warnings in American and European contexts, red has strongly positive connotations (luck, happiness) in many Asian cultures. In African cultures, its meaning is highly diverse and context-dependent. For global audiences, data scientists in 2025 must be culturally sensitive, provide clear labels and context, and consider alternative color schemes to avoid misinterpretations. Assuming a universal meaning for red can lead to flawed understanding and decision-making.”

### **Analysis**

**Definitions of terms & comparisons** - The AI brings out the different fields and definitions of neuroanthropology accurately. It references reliable sources hence its understanding is enhanced. Comparing the outputs with trusted sources and academic papers the comparison and definitions is correct.

**Biases** - Comparing the above outputs with class work on biases and articles read, the Gemini responds is spot on such as referencing the GDPR for the European union. The AI has good knowledge on challenges with African cultures data unavailability.

**Red color** - The responses emphasize the different cultural understanding of visualization sensitivity to different color meanings as learned in class such as red color contrasting meaning in Asian culture compared to American and European setups.

### **3. Conclusions**



Overall, the results of the AI models are quite impressive. All AI models cover the topics in a way that beginners can easily understand. For text-based concepts, large language models do seem to be mostly accurate. However, the AI models do appear to oversimplify and don't mention nuance as much as they should. For example, for biology it claimed the basal ganglia as important for language development without mentioning that the specifics of its role has not been confirmed by science. It is also clear that some AI models are better than others for certain tasks. ChatGPT and CoPilot seem to be better at text-based information. Although AI LLMs are useful in the modern age, they should be seen as simply one of several tools. This is important for education as well as business. Teachers who want factual information should treat AI models as another source and not the be-all-end-all of their research. Businesses who need information on how to improve their processes should also be careful: just as one would not trust one source unconditionally, one should also not trust an AI model. It is best to compare different sources of information, which can also include comparing the results of different AI models for the same question. For any organization, be it public or private, factual information is key, and we as humans must use AI wisely not just for ourselves but for the benefit of all.

## Citations:

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