Day 1: Introduction to scientific thinking and cognitive neuroscience

Total time: 65 minutes

1:50 to 2:00: Introduction

Name game: Hello I'm not X. That is X. I am Y. If I had a super power…

What according to you is science? *Take a few responses.*
Science is about curiosity. About asking questions about the world and answering them. It is a way of thinking!

2:00 to 2:10: Scientific thinking

Situation: You see two people talking. Suddenly they both start talking more loudly. Soon they are shouting. One of them was holding something in his hand and he throws it down and walks away.

Why did the person throw something down and walk away?
<Expected answers: He was generally angry. He was angry because of the thing he threw down. He did not want to hold it any more. He suddenly remembered something and so dropped it in a hurry to leave.>

How do you know this? – They'll give some answers. Connect it back to prior knowledge about the world.

These are all theories we have in order to explain some phenomenon in the world. These theories are built on some previous knowledge we have. But there are many theories and we don't know which is the correct one. So we have to go about testing it.

How would you test these theories? Take their answers. Talk about it in terms of "testable hypothesis".

How would you test these hypotheses? What kind of information would you need? Talk about relevant information you can get. This called collecting "data".

2:10 to 2:20: Introducing cognition

We've seen how we can take a phenomenon in the world – a person throwing something and walking away – and seen how we go from creating probable theories to testable hypothesis to conclusions. Now can we explain other phenomenon in a similar way? For example why are you able to remember some information better than other information?

A very broad question. So maybe we can look at specific instances where we remember some info better than others. Say you read a story three times and you read another story just one time. I asked you questions about the story. Which would you remember better?
Why?
What is your hypothesis?

Scientists had similar hypothesis. Conducted an experiment.

Word list:
Question
Propose
Kind
Modern
Signal
Angle
Body
Opposite
National
Invite
Subject
Future
Silence
Adventure
Cousin

What words were remembered? Did the results match with the results of the actual study? Talk about primacy and recency effect.

Why do the results of the original study make sense? If we didn't find those results, what could be the possible reasons? (small number. Lack of control in words. Etc.)

In this case, we measured behaviour to understand how thinking works! Remember we were talking about relevant kinds of information? Sure. Behaviour is relevant. But thinking happens in the brain. So we must be able to look at the brain to understand how thinking happens right?

We can! But we need some "prior knowledge" about the brain in order to be able to do that! So lets look at it!

2:20 to 2:30: Introducing the brain and ways of measuring brain activity

How does the brain work? Structural and neural level explanations. Show videos
https://www.youtube.com/watch?v=vyNkAuX29OU

https://www.youtube.com/watch?v=XSzsI5aGcK4
https://www.youtube.com/watch?v=owFnH01SD-s

So now that we know some information about how the brain works, lets see what are the ways in which we can measure brain activity. Any ideas?

- Based on neural connections – MRI, CT – these are static images. They will tell you what happened to the brain over time
- Based on measuring electricity emitted by the brain – remember action potentials are basically electric signals
- Based on the idea that all cells need energy that is received by flow of blood. So by measuring the flow of blood – fMRI and PET. fMRI – oxygen in the blood. PET – inject a radioactive substance and then measure that.

2:30 to 2:40: **Introducing cognitive neuroscience**

We know of methods to measure brain activity. But how can we understand how the human mind works? Or how thinking works? Ask them!

Two things:

1. Look at how different functions are implemented in the brain. Helps us understand more about how the brain works and why some people are able to do somethings better. For example, some people have language deficiencies. And we know that is because of damage to specific parts of their brain (called Broca's area and Wernicke's area)
2. Correlation! Correlate behaviour to brain activity. How does music affect attention? we can look at how the brain activity is different for people who listen to rock music and people who listen to slow music when they are performing an activity that requires them to pay attention.

So you are taking a cognitive phenomenon – attention in this case – and understanding that cognitive phenomenon by picking factors that could affect this cognitive phenomenon – like the type of music – and then measuring the brain activity to see if there is any difference! Using brain activity to understand how cognition works is called cognitive neuroscience! And in the later classes we will use what we learnt about experiments earlier today to design and conduct an experiment in cognitive neuroscience!

So which of the many technologies will we use?? EEG!

Basic explanation of how EEG works. How it can be used for ERP also??

2:40 to 2:50: Introducing the equipment

Put the cap on someone! Show them how it looks, how it works. Why no muscle activities! Importance of being in a quiet room – ask them why it is important! With what we are doing, attention is easiest to measure! Talk a bit about alpha waves?

2:50 to 2:55: Conclusion

Come up with one (or more) factors that could help you understand the cognitive phenomenon of attention!
Ask what was the one big word they remembered from today's class?

Day 2: Designing an experiment and demonstrating Emotiv

1:50 to 2:00: Settling down, making groups and walking to the computer lab

Today we are going to go the whole way in designing an experiment – right from coming up with a probably theory, doing some background research, deciding the variables, coming up with a hypothesis to designing parts of the actual task. And I also want to put on this cap on one of you and show you brainwaves.

2:00 to 2:15: Coming up with an operational variable

We are interested in looking at how independent variable can affect dependent variable. Example, how the mass being towed by a truck, affects its ability to accelerate. What are the independent and dependent variables?
Now it is very clear what mass is and what acceleration is. Clear physics definitions. But when we are studying humans, sometimes not as easy. For example, you want to know how the food you eat affects your mood. What do you mean when you say food? Do snacks count? Will you measure the amount of calories they eat? In one day or one week? So I have to define food – not a dictionary definition – but rather what I mean by food in my experiment. For example, I can decide to say by food I mean the total amount of calorie intake in one week. Or I can define it as the total number of calorie intake from vegetables. Or maybe I define it as the number of times I eat outside in a week. All of these are called "operational definitions"

Similarly we need to define what we need by mood. Is it going to be self rating? Are we going to measure how they react to other situations? Apart from dependent and independent, there is also a "task" – i.e. what are the participants required to do? So for example if the definition I choose is how they react to other situations, then the task that I give them for example might be showing them videos and asking them to answer subjective questions.

I have chosen the dependent variable and the operational definition. We are going to look at attention and the way we are going to measure it is by looking at the electrical activity in the brain when the participants are performing the task. So today we are going to pick the independent variable – the factor that affects our dependent variable – and make an "operational definition".

Brainstorm. Vote.

Come up with an operational definition.

2:15 to 2:30: Research time with the group

We now have an operational definition of independent variable. But now we have to make a hypothesis – a prediction. But prediction can't just be something you make up. It has to be based on background knowledge. We are going to use google scholar. Work in your groups now. 10 minutes to look up things. 5 minutes to summarize.

2:30 to 2:40: Coming up with hypothesis

One sentence from each group about what their prediction is and why. Final hypothesis. One sentence about what task they will be doing. Lets look at something that requires attention but not memory. Press Z if you see 1 and and / if you see 5.

2:40 t0 2:55: Demonstrating the emotiv cap!