Key:

V = Dr. VanMeter

V: The MRI scanner is a closed tube; inside the tube we have a very powerful magnet. We measure the strength of our MRI magnets using the technical units of teslas. Most clinical MRI scanners are 1.5 tesla. This scanner and most scanners used for research are 3.0 tesla. A 1.0 tesla magnet is as powerful as the magnets used in a junk yard to pick up a car and move a car around. And the purpose of this big powerful magnet is to align the protons inside the person's body. And what we measure when we're doing MRI is the participant's protons, the magnetic fields that the protons are generating. Protons are positively charged and create a magnetic field because they are also spinning. So the purpose of our big powerful magnet is to get as many of these protons aligned with the scanner's magnetic field and the more of these protons that become align, the better our pictures will look, the better the quality of the pictures will be. Hearing protection is always required because the scanner creates a lot of noise. It makes a loud banging noise and so participants are always given some form of hearing protection. There's also what's around her face that was placed above her is what we call RF coil. In this particular case, it's one designed for the head. And so, what this is going to do is it's going to measure the energy from the protons and that's how we're going to generate our pictures. And so, we want that particular piece of equipment, the RF coil to be as close to the body part that we're imaging as possible. One particular type of MRI that we do for researcher is called functional MRI or fMRI for short. This is a technique that is designed to give us information about neural activity, how the brain is functioning. And what it relies on is the magnetic properties of the blood and in particular, red blood cells that have oxygen attached to them do not create a magnetic field but red blood cells that have had the oxygen extracted from them have a magnetic field. And that difference in the effect of the bloods based upon its oxygenated state is what gives us a signal that we can measure with MRI. So, what happens with a brain when it begins to start doing some type of work, it will produce neurons that will cause neurons to start working. And as those neurons start working, they'll start using the oxygen that is in the red blood cells. So, the first scan we do in all of our MRI scanning Sessions is what we call a localizer, or scout image. When Macy was positioning Andrea in the scanner, she had told the scanner with a laser light about where we were going to be imaging, i.e. she focused the laser light about on what we call the orbital frontal ridge just above her eyes, about where the eyebrows are. And that's about the middle of the brain. But to be precise, when we do our scans, we want to be able to position them right over her brain. And so that first really quick 17 second scan just gives us a very quick picture of actually where her brain is located. So, it's only purpose is to give us an image that we use to position all the other scans. And so right now what Macy is doing that's first 17 second scan is already done. She's now positioning her box right over the brain so that all of the parts of the brain that we need to capture in this experiment will be covered by the box. Beforehand. Andrea had already been told to memorize five different images. And in this experiment, we're having her pretend like these are co-conspirators of hers. And at different points in the experiment. We're going to have her tell the truth, yes, I know this person and pick them out from a lineup and in other parts we're going to have her tell us a lie. So, Andrea, as we practice before you went into the scanner on this experiment, I want to either tell us the truth or tell us a lie. Before we show you images, we will prompt you to tell the truth or to tell a lie. Every time a lineup of three images comes up three people, if it's the truth condition, please choose the picture that the button that corresponds to the picture where your c-conspirators located in the lineup. If it is a lie condition, pick one or the other two images that correspond to not one of your conspirators. Is that clear?

Andrea: Got it.

V: All righty. So, this is what she is hearing inside the scanner. So, the experiment has started. And we told her before this part of the experiment started that she is either in this case to tell us the truth. So, if she sees one of her co-conspirators in this lineup she is to press the button that corresponds to where they are in that three-person lineup. And then here in a few seconds, it's going to switch to the lie condition and in that case, when she sees one of her co-conspirators, we want her to pick out, so this is the lie condition, pick one of the other two individuals in the lineup and not her co-conspirator. So, this is an excellent demonstration of how we construct our fMRI tasks. In fMRI, we're always trying to compare two different conditions. And so, in this particular case, our two conditions are telling the truth or telling a lie. And then after this experiment is done, what we will do is we will use a bunch of processing software to compare the scans that were collected when she was telling the truth with those when she was telling a lie. And the difference between those two sets of scans is what is going to be used to determine the areas that are more active when the lies being told and when the truth is being told. And from that, that is going to be our punitive signal or indication of what areas are involved with lying. So, what these images are, the instantaneous snapshots of pictures of Andrea's brain. In this experiment, every 2.3 seconds, we're getting a new picture of her brain and we're not seeing much visually change here, even though this is a new image every 2.3 seconds. But what we can do is in the statistical analyses is we can look for these very small changes differences in the intensity of these images, to determine where the areas that are more active during telling the lie than telling the truth. So, these pictures are composed of what we call voxels. Voxels, are just simply a three dimensional pixel. And so, it's three dimensional so it has both a width and length but it also has a depth to it. So, we're essentially breaking up all the different pieces of the brain into these little voxels. When we're doing our functional MRI experiments, the voxel sizes are pretty chunky and we'll see that here in a minute. By that I mean the voxel size for the purposes of detail of the anatomy of the brain is pretty big. In particular, in this experiment, we're using a three millimeter cubic voxel so it's three millimeters on the side. Her whole brain has been broken up into these three millimeter cubes. And then visually, we can represent that on the screen. Before we can show you any pictures showing the areas where Andrea was lying versus telling the truth, we have to do a lot of processing of the data. And in particular, there's multiple stages of processing that we do. One of the things that we always need to do is do what's called motion correction. So that's taking all of those individual pictures we collected using the fMRI technique and correcting for the motion so that it appears as if there was no movement from the very first scan to the very last scan. After that, one of the processing steps that we will do is take her functional MRI data and co-register it to the high-resolution anatomical scan. And what this will allow us to do is to be able to very precisely locate on her brain where the activity is occurring. The next step in our processing will be to take her individual high-resolution brain and warp it into an atlas space. An atlas space is a space that has been pre-defined where all the different parts of the brain are labeled very nicely. And it is a space in which if we're combining groups of individual people's brains together, when we click on a given voxel location it's at the same point in everybody's brain, the same anatomical location. And then finally, before we do our statistical analyses, what we'll do is we'll actually smooth the data. So, the smoothing is a step in which we're trying to get rid of any noise in the image in a spatial sense. There's also a temporal filter that is applied and again this is to remove noise that is occurring across time. One of the things that we contend with when we're doing our fMRI experiments is that over time the magnetic signal we get starts to drift. And so, for very long experiments, experiments lasting 20 minutes or longer, we will have to deal with that drift. And then there's other things that cause the signal to vary across time. So, the temporal filtering is intended to deal with that type of noise and then finally, we're able to then go and do our statistical analyses. And in particular we try to collect data on at least 15 individuals, but often many more individuals. And in the statistical analysis, what we'll do is we will average across all those individuals to identify in the broader population from which those individuals are drawn, what are the areas that are active for our condition of interest versus the condition, that is our control task. And so, in Andrea’s particular task, those two conditions were, tell me a lie versus telling me the truth. And so that is the comparison that we would make in that analysis. One final point to make about these analyses is very difficult to get reliable data on individual subjects. The vast majority of what is published in the literature using this technique is a composite of a group of subjects. So, it is not typically the case that we're looking at individual subjects and how their brains are activating. There are some studies that do this type of analysis, but it is relatively rare. There are some analysis tools that are newly developed that are helping us to better handle individual analyses, but it's still in its infancy.