ABBY NOYCE: Today, we are talking about attention. [HUMMING] And the the goal for this week, we've spent a week looking at how information gets into your brain through the visual modality in some detail. So this week, we're going to talk about what the brain does with all of this information. So we're going to talk today and tomorrow about attention today in an abstract from the cognitive perspective sense tomorrow, actually start looking at what goes on in your brain when you attend to information.

I will probably talk a little bit about ADT and ADHD, and some of the medications that people use for those, and what we know about how they work, which is not nearly as much as one might like. And then on Wednesday and Thursday we'll talk about working memory, which is the holding information, what you're doing with it portion of memory. And then next week, we'll segue into longer term storage of knowledge and working with it.

So attention. William James has this lovely description of attention. William James, remember, is the philosopher and psychologist from the late 1800s. He says attention is the taking possession by the mind in clear and vivid form of one out of what seems several simultaneously possible objects or trains of thought. It implies withdrawal from some things in order to deal effectively with others.

And this is a good description of what it subjectively feels like to attend to a stimulus of some kind. We all know what paying attention feels like, or what it feels like when you don't have enough attention to go around all the different tasks you have to do. But James is very good at taking those subjective experiences we all have and putting them into words. A more modern definition of attention is basically just that you are working with one source of information that's coming in.

So we talk about focused attention when you're really only dealing with one source of information. We'll talk about undivided attention, when you're trying to attend to multiple things at once. Usually when you try and do that, your performance on both falls off. You can't fully attend to two things at the same time. So you've got a limited amount of attention that you can give to the world around you. And when it runs out, you've got to drop something.

AUDIENCE: It's like multi-threading.

ABBY NOYCE: Yeah, except it's limited differently. But it's a reasonable analogy. Just be careful with it. What's multi-threading, [? Naman? ?] Would you like to explain to the rest of the class?

AUDIENCE: It's when a crossover can only do one function at a time. So what the operating system does is [INAUDIBLE] programs at the same time, it switches between the programs really, really, fast.

ABBY NOYCE: Yeah. So you guys probably know your computer slows down if you try to do a bajillion things at the same time. And that's one of the reasons why. It's working on task A, and then task B, and then task C, and cycling back to the beginning, which isn't quite how divided attention tends to work in humans. But it's the same problem, that when you're trying to do a lot of things at once, it falls apart.

AUDIENCE: Is there a gender difference in that?

ABBY NOYCE: On divided attention?

AUDIENCE: Yeah.

ABBY NOYCE: I don't know about that, per se. But there's definitely-- there are really well-documented gender differences in various kinds of spatial visual attention tasks, looking for a stimulus and a field of other things. And there's some really interesting research on this that says it correlates really heavily with the fact that way more guys than girls play video games.

So if you take a male and a female subject pool, like standard college freshmen, you'll see the guys do a lot better than the girls on these kinds of tasks. If you then have them play-- I think honestly, they used a first-person shooter game, like "Quake" or something, where you're going around looking for enemies, jumping out from behind other targets, and things like that. You've got to really learn to be quick to respond to visual stimuli.

And testing them again, the differences in performance were a lot smaller. So spatial attention is definitely something that can be learned and can be improved on. So we're going to start out talking about some cases where people's attention manages to drop an important piece of information coming in. This is a classic study from 1998. The experimenters, one of them went up to a pedestrian on campus and said, hey, can you tell me how to get to the student center, or I don't remember what the exact location they were looking for was.

They asked for directions, and the passer by started giving these directions. And mid-conversation, two people carrying a door cut right in between the conversations so that they were cut off from each other for a couple of seconds. And the two people carrying the door were, in fact, part of the experiment. And the person who'd originally stopped the pedestrian and asked the question swapped places with one of the people who was with the door so that when the door had left and the random passerby who was being asked for directions could continue his explanation. Then the person he was talking to was a completely different person.

AUDIENCE: In the same clothes?

ABBY NOYCE: Roughly, but not identical. You can see the photo on the bottom right there. So there are two guys. They're both dressed in like a dark outer layer and a white shirt on. But they really don't look anything alike.

AUDIENCE: Yeah, they do.

ABBY NOYCE: They look a little bit alike. They don't look a lot alike.

AUDIENCE: You'd be able to tell the difference [INAUDIBLE].

ABBY NOYCE: I think you'd be able to tell a difference in a color photo too. One of them's wearing a jacket and one of them is wearing a sweater.

AUDIENCE: One of them's balder.

ABBY NOYCE: One of them is way balder. So anyway, so about--

[INTERPOSING VOICES]

ABBY NOYCE: When they finished you know getting directions from the pedestrian, they said, OK, so we're required to tell you we're doing a psychological study, blah, blah, blah. If you don't want us to use your data, we won't use your data. And with some questions. One of the questions asked was, did you notice that I'm not the same person who originally stopped you and ask for directions. And about 50% of pedestrians said, yeah, I noticed. And the other half said, nope.

So this is a classic example of your attentional system disregarding a big chunk of information, the appearance of the person, the appearance of the person you're talking to in order because it's irrelevant in some ways. Anyone here work retail behind a register? I've done that, and I know that there's been days when it's busy, and you're just pushing people through as fast as you can, and you ring somebody up, and you hand them your change, and you say, have a nice day. And right about then when I make eye contact, I notice that this is my mom's best friend. Just didn't see it before because I was so focused on other stuff.

So one of the big things that attention does is it disregards some of the information that's coming in because otherwise, there's just way too much for your brain to process at any point in time. All right, so this is a phenomenon called change blindness, where something changes and you just don't see it happen.

AUDIENCE: Is there any way to build your attention span or--

ABBY NOYCE: What sort of attention span?

AUDIENCE: Is there a way to be able to multitask accurately, or--

ABBY NOYCE: Better. So when you're doing divided attention tasks-- and we'll come around to this again in a minute. But one of the things that makes a lot of difference is how well you know the tasks we're doing. So, for example, novice versus experienced drivers, novice drivers who are asked to change a radio station or something will look away from the road for a lot longer than experienced drivers will.

And that's partly because just one more familiarity with one or better with both tasks means that it requires less attention to do them. And it also gives you better judgment about how to switch your attention back and forth optimally. So experienced drivers have a good sense of how long can I look away from the road before bad stuff happens more so than someone who's only been driving for a couple months or a year or whatever.

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: Anyone here know anyone who texts while driving? My sister does that. And I will not-- she does it when I'm in the car. I take the phone away from her.

AUDIENCE: It's scary.

ABBY NOYCE: I don't get it. OK, so this is one kind of change blindness. Another kind of change blindness, information is relevant and ignores other input. This is what we just said. So that's attention that's centrally controlled, where you're deciding what sort of stimulus you're looking for in some way, either consciously or unconsciously. If you're at a crowded party, and you're looking for your best friend, and you know that she has a red shirt on, then you're going to be looking, scanning the crowd, looking for something red.

And if she has unbeknownst to you changed into a black shirt, you're going to have a much harder time finding her. You're not going to be attending to the people wearing black. You're just going to disregard them.

So top down in this case means centrally controlled, right? It's not being-- as opposed to a stimulus driven attention. So alternatively, if you guys were all sitting here focusing on me, and the tripod in the back of the classroom fell over and went bang, you'd probably all turn around and look, right? So that's a stimulus, grabbing onto your attention, and pulling it away from whatever's going on that you were trying to focus on before.

All right, here's a task for you guys. We're going to see a white team and a black team dribbling some basketballs. And I want you guys to watch the video and count how many times the kids wearing white pass the basketball. Are you ready?

Go.

How many times?

AUDIENCE: 14.

ABBY NOYCE: 14 [INAUDIBLE]? Who's seen this demo before? OK, anyone notice anything weird? Watch it again. Don't try and count the basketballs. Just watch, see if you notice anything odd going on.

[LAUGHTER]

Ready?

[LAUGHTER]

AUDIENCE: Wow.

ABBY NOYCE: Your attentional processes decide that they want to watch this piece of information, and they just throw out everything else.

AUDIENCE: That was there the whole time?

ABBY NOYCE: That was the exact same video.

AUDIENCE: Since it was black, and all the other [INAUDIBLE] you got confused because you're not paying attention to those.

ABBY NOYCE: Yeah, you disregarded all of the people wearing black. And that's, I think, a big part of what happens there. I think it was-- I don't know-- a white gorilla, or a snow leopard costume, or something, then you'd be a lot more likely to see it. But because it fits in with this other category that you've decided to disregard, then your system just throws it out. So, again, disregarding a good chunk of the input that comes in.

[INAUDIBLE] grabs onto to information that's relevant in some way and ignores other stuff. It breaks when you've got lots of different stimuli trying to get your attention at the same time. If you're trying to do your homework, and holler at your little brother, and watch a TV show all at once, probably one of these things is not going to get done very well. Everybody here? Good. Thank you.

The other interesting question for attention is what constitutes information that's relevant? So one kind of immediate [? instances, ?] OK, probably in an evolutionary sense, information that in some way affects your survival, right? We know that our attention is grabbed by unexpected stimuli of some sort. If there's a loud noise, or something moves in your peripheral vision, all of these are things that will cause you to direct your attention.

On the other hand, there's a lot of things that are really relevant to your survival that we don't pay any attention to, your breathing, your heart rate. All of these are things that are, in fact, controlled by your brain. But we don't put any of our conscious attention into making sure that these things keep happening.

AUDIENCE: Would it help us if we had to.

ABBY NOYCE: Yeah, see? You wouldn't have any intention left over to do anything else. So to some extent, weird stimuli that are relevant to survival, but because we are creatures of these great big powerful cognitive capabilities, we can direct our attention to whatever we want, which is not directly-- this attention got grabbed-- is not directly relevant to--

AUDIENCE: Was that [INAUDIBLE]?

ABBY NOYCE: No.

AUDIENCE: That's strange.

ABBY NOYCE: It was clever. And my train of thought is broken. So attention that's relevant to survival, but we also have these big, strong powerful brains. And having all of these abilities is adaptive, but we can do things to them that are not necessarily adaptive. Yes, that's where we were going with this. OK.

AUDIENCE: Like how you have a flashing light to grab someone's attention [INAUDIBLE]. If you flash it too rapidly, then it's almost as if it was just shining constantly, and then attention fades.

ABBY NOYCE: Well, is that an intentional thing, or is that a perceptual limit? Because that's going to have to do in part with how fast a stimulus your rods and cones can perceive. And there is certainly something to that too. A computer monitor, where if you look at it sideways, you can see it flickering. But if you look straight at it, it looks OK. Less of a problem with flat screens, but with old monitors.

AUDIENCE: [INAUDIBLE] you can see change--

ABBY NOYCE: Yeah, because your rods reset. They can respond to a new stimulus faster than the cones can. So and we know our peripheral vision is more sensitive to motion in a lot of ways. So this is one that goes with that.

AUDIENCE: So if someone's in front of you, or if someone is attacking in front of you, would you respond as fast if someone tries to attack you from the side?

ABBY NOYCE: Probably not on an order that makes any kind of difference in that real life circumstance, in part, because a person who's already in front of you probably has more of your attention in the first place than somebody on your side. But we're talking differences on the orders of a couple hundred milliseconds. Less than that for this. We're talking 70 hertz monitor or something that looks good when you look at it and flickers.

AUDIENCE: If you look at that with peripheral vision, would you--

ABBY NOYCE: 70, for me. Yeah. 70 for me is about where I stop having flicker issues and CRTs. Old school 60 hertz ones give me headaches. Anyway, so come in. There we go. So that's a demo of what's called attentional blink.

So it is a short period of time where incoming information just doesn't get registered. So in this case, it's after there's one. After you see one target, there's a period at which that information about the next target that's coming in does not get seen. Another good example of this is that as we look at things, we move our eyes around, right?

We have what are called saccades, where you jump from one focal point to another focal point. Your eyes, you don't register any of the information that comes in while your eyes are moving like that. And a good demo of this is if you look at the person sitting next to you, and have them look at one of your eyes, and the other of your eyes, and go back and forth, and you'll see their eyes moving just fine.

But if you try and do this with yourself in the mirror at home-- look at your left eye, look at your right eye, look at your left eye in the mirror in your reflection, you won't actually see your eyes move. You'll just see yourself looking at each of those. Your brain just throws out all of the visual information that's coming in during that jump while the world is sliding across your retina at really high speed. It doesn't use it.

Try it. Turn around and look at somebody next to you, and have them move their eyes back and forth. Like here, Helen and Natasha, Natasha, look at Helen's left eye, and then her right eye, and then her left eye, and go back and forth between them. Helen, can you see her eyes moving?

AUDIENCE: Yes.

ABBY NOYCE: Try it in front of the mirror at home. You won't see it. It's cool. So this is a case of attentional blink where your brain just-- not because there's a target that is eating your attention, but because your visual system, for whatever reason, always just throws out whatever is coming in while you're saccading from one point of focus to another. Why do you think your visual system does that?

AUDIENCE: Wait, what was the question?

AUDIENCE: For computational purposes?

ABBY NOYCE: Maybe, so that it has some downtime to think about things, you mean?

AUDIENCE: Well, even if it kept information, wouldn't you just see a really big-- a blur or something because your eyes would be [INAUDIBLE] so fast, [INAUDIBLE] keep track of it.

ABBY NOYCE: Yeah. So the usual conventional wisdom about this is that tracking an object as it moves across your field of vision is-- it takes some work. It takes some matching up, and that it just isn't worth the processing power that it would take to track everything as it moves around. But you do it OK. You just do a piecewise. You match up an object over here, and then if I move my eyes over here, I can still match the same objects up.

So we don't really know for sure why the visual system does it. But it's pretty well documented that it does. If you have people who are reading something, when you read, your eyes jump from word to word. And if you have them fitted with an eye tracker that can see them do this that's fast responding enough to project something like mid-saccade, then you can have their story that they're reading be interrupted by giant presentation of an apple or something, and they just won't see it, as long as it's gone back to the original story that was on the screen by the time that saccade is finished. So we're talking single-frame presentation.

OK, so we have attentional blank, which is this temporal breaking of attention.

AUDIENCE: Is that how subliminal messages are sometimes put in television?

ABBY NOYCE: So subliminal messages aren't necessarily taking advantage of that particular saccading. They're just too quick for your brain to see and process. So getting stuff, a stimulus into your system takes a certain amount of time. And people who believe that subliminal, that the single frame subliminal messaging works, believe that it gets input and processed at some level, but doesn't make it into conscious perception.

AUDIENCE: Wait, what is subliminal messages?

AUDIENCE: So there's kind of the classic version. The classic urban legend story of this is the movie theater that during the previews enters [INAUDIBLE] single frames that say popcorn is delicious, and you're thirsty, drink Coke, and whatever else, and sees their concession sales-- concession stand sales go way up, which I'm pretty sure is just an urban legend.

AUDIENCE: [INAUDIBLE]. Oh, there was a [? stat ?] problem they had back during the school year. And it mentioned that. How would you design an experiment with that--

ABBY NOYCE: To see if this works?

AUDIENCE: Yeah.

ABBY NOYCE: Yeah, and it's a worthwhile question. But there isn't any really good solid data showing that it does work. It's like one of those-- oh, that would be cool. That would seem to make sense. But it doesn't seem to actually happen cases.

AUDIENCE: Well, that's good to know.

ABBY NOYCE: Isn't it good to know? Subtler kind of subliminal stuff, like product placement in movies, does seem to work. So if you have a video, and the main character in it is drinking a soda, and it happens to be a Coke, and I give you a choice between Coke and Sprite afterwards, you're more likely to pick the Coke. But that's a very different kind of--

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: Yeah. So that seems to actually influence the choices people make, if it's a character that they like and identify with. I don't know if anyone's done any studies were a villain drinks Coke and does it make their sales go down. But probably Coke would not pay to get their products placed in that kind of context, so we'll see. Anyway, so attention breaks-- yes?

AUDIENCE: I have a question about subliminal messaging with audio. [INAUDIBLE]?

ABBY NOYCE: If you play this backwards, you can hear something?

AUDIENCE: Yeah. Yeah. So does that actually work, or does that--

AUDIENCE: Wait, what?

ABBY NOYCE: The majority of the, if you play this backwards you can hear something things, I think can get chalked up to the fact that humans are really good pattern recognizers. And so we tend to find patterns even when there isn't one there.

AUDIENCE: OK.

ABBY NOYCE: I don't think it works, because anything played backwards sounds like gibberish, right? You can't make sense out of--

AUDIENCE: I can speak backwards if I really try to.

ABBY NOYCE: Yeah? I think this might require demonstration.

AUDIENCE: Do it.

AUDIENCE: OK, the backwards is composed of two phonemes. So you just say phoneme backwards.

ABBY NOYCE: So it's just of?

AUDIENCE: Of.

ABBY NOYCE: Is that what it actually sounds like if you run it backwards on an audio tape?

AUDIENCE: Yes.

ABBY NOYCE: OK.

AUDIENCE: You have to say the phoneme backwards, basically.

AUDIENCE: [INAUDIBLE] backwards?

ABBY NOYCE: Phonemes are the units of sound that make up--

AUDIENCE: Split it up into each sound. So the is made up of two sounds, the th sound and the uh sound. So yous say it backwards. So [INAUDIBLE] would be the backwards.

ABBY NOYCE: How about--

AUDIENCE: Wait, isn't it [INAUDIBLE]?

ABBY NOYCE: That's the spelling backwards. But even in languages that are not English-- English is all messed up spelling of its own-- the relationship between a sound and its spelling are loose, especially where you've got things like the th where the two letters are actually making a completely separate sound. Anyway, yes, cool. Moving along, so what happens when your attention fails at some of these tasks?

So there's some possible modes of failure, possibilities, modes of failure-- I fail-- one of which is that it's simply sensory limitations, that your sensory system can't handle the full amount of information that's coming in. So to some extent, the things that we miss could be chalked up to, for example, you have less acuity in your peripheral vision. You're less likely to see things.

Subjects who are doing a visual perception task on a monitor are more likely to miss targets in the periphery of the monitor than targets that are in the center. But an awful lot of attentional failures are not just explained by sensory limitations. Most kind of models of attention, most of the way people who study attention are thinking about it, they're thinking of it as a bottleneck. Information comes in, and then there is a-- and then only so much of it can get passed on to higher levels of processing. So most of the information that's coming in just never makes it.

And some failures in attentional tasks seem to be response bottlenecks. A response bottleneck is like if I tell you to push the left button if you see an F, and push the right button if you see a C, and then I show you both of them at once, but you'll be slower to respond to both of them at once than you are to either one individually, it probably has less to do with a sensory limitation, and it's possible that it's an attentional bottleneck. But it's also possible that coordinating one response and then the other response is where the limitation is, where the processing is slowing down.

Response bottleneck might be like-- I was teaching my sister to drive a stick shift car earlier this summer. And so she can drive a standard. She has an automatic she's been driving for five yearsish. But she hadn't driven a stick before. So she can start, or stop, or shift gears. But ask her to do something on the streets where you're making a right hand turn-- so you've got to slow down, and then you've got to shift the car into another gear, and then you've got to flip the turn signal on, and you've got to turn the wheel, and you've got to do all of this stuff at once is really hard because that there's a response. And all of these responses to that turn are taking up a lot of time and a lot of attention that she might not otherwise have had to use.

So bottlenecks, where attention is not being able to deal with everything that's happening, or not being able to do it as quickly and efficiently as it can deal with one thing happening, might be in the amount of information that's coming in. It also might be in how you're responding to that.

All right, so we talked a little bit about multitasking, dual tasking. Dual tasking does improve with practice. If you want to get better at multitasking, this means that you should do some multitasking, and you'll probably see your ability to monitor multiple tasks go up.

Dual task interference is just this thing, where doing one thing decreases your performance on another one. If you're doing two visual tasks at once-- you can't read two books at once, not at the exact same time. You might be able to swap back and forth between them. But also, if you're doing a visual task and an auditory task, you'll still see this interference, where doing one of them will actually disrupt your performance on the other.

And as you get better at either of the tasks involved, then having something else going along with it gets easier. So if you're a good cook, and you cook a lot, then you might be able to talk on the phone and chop an onion at the same time, whereas if you don't have a lot of practice with those particular kinds of chef knife maneuvers, this may lead to a trip to the emergency room.

AUDIENCE: But is it possible to be better when you're dual tasking with a certain ask than it is if you would do it by itself?

ABBY NOYCE: Do you have a particular case in mind?

AUDIENCE: Yeah. I type while I read. [INAUDIBLE] I type better when I read it because then I do typing when [INAUDIBLE].

ABBY NOYCE: Cool. So that's probably not-- so one possibility here is that that's not an intentional thing. What do you mean typing when you read it? You look at the screen while you type?

AUDIENCE: No. [INAUDIBLE].

ABBY NOYCE: And take notes and stuff?

AUDIENCE: Yeah, yeah, yeah. And I think it's faster, [INAUDIBLE].

ABBY NOYCE: If you think about something that's like a high speed physical task like that, it's like sometimes something like that, it's like people say, my hands know how to do it. And then if you stop and think about it, you mess yourself up. Is that one those? I feel like one of those things.

[INTERPOSING VOICES]

AUDIENCE: Yeah, [INAUDIBLE], about overanalyzing actually typing. If you really sat there and thought about A's here--

ABBY NOYCE: And then this means that I have to move my ring finger up, and my middle finger down. Yeah, so that's probably a different kind of concentration or something that's not helpful. I don't know. It's an interesting data point though, and it's a good one.

AUDIENCE: She's experimenting.

AUDIENCE: Yeah, how many of us [INAUDIBLE]?

AUDIENCE: Yeah? What?

AUDIENCE: [INAUDIBLE].

AUDIENCE: Yes.

AUDIENCE: [INAUDIBLE] an experiment now.

AUDIENCE: No, it's true though.

ABBY NOYCE: OK, how would you set up an experiment? Watch out, I'm going to give you homework. OK, so the classic dual task interference that is a hot political issue these days is talking on the cell phone while you're driving. Who knows somebody who does this? Who's been known to do it?

[INTERPOSING VOICES]

AUDIENCE: I do it.

ABBY NOYCE: City kids. I do it. I do it. I'm a bad person.

[INTERPOSING VOICES]

ABBY NOYCE: So--

AUDIENCE: When can you get a learner's permit?

AUDIENCE: 16.

AUDIENCE: Unless you were born in '94 or later, in which Massachusetts decides to increase [INAUDIBLE]?

ABBY NOYCE: 17. They move it up.

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: Oh, that's late. It's later than New York.

[INTERPOSING VOICES]

AUDIENCE: No, I think '94 and later.

ABBY NOYCE: What did it used to be?

[INTERPOSING VOICES]

ABBY NOYCE: OK. Yeah, I don't know. I grew up in the state of live free and kill yourself. Right, so we have a real life dual task interference situation. And Stayer and Johnston put together this study where they had participants do a simulated driving task, so in a little car simulator. And they had them either-- they had a course set up. They were asked to follow another car through a city, road, traffic lights, whatever.

And they had their subjects either listen to the radio-- they even got to pick the radio program-- or talk on the phone.

AUDIENCE: Listening to the radio, did they actually have to concentrate on the radio, or did they just--

ABBY NOYCE: They got to select a radio program and have it on. So I think what they were trying to control for was just having some auditory, that it wasn't merely having an auditory stimulus in the car.

AUDIENCE: Oh, [INAUDIBLE] OK.

ABBY NOYCE: Right. It's the control group for the talking on the phone so that you know-- you can't just say, oh, but having noise in the car makes people do poorly on this. So they had to go through this course. There'd be a traffic light that would go red or green at periodic points throughout the course. And participants had to push the brake when they saw the traffic light turn red.

So thinking about the experiment design stuff we talked about in the very first week, what are these guys trying to study? What is the question they're trying to answer? Helen, what are they trying to answer?

AUDIENCE: If you're talking on the phone, whether or not it stops you from thinking.

ABBY NOYCE: Yeah, whether it messes up your driving ability. Good. So what's the independent variable here? What's the thing that the experimenters are changing to compare two groups? [? Naman. ?]

AUDIENCE: Auditory input as well as the need to [INAUDIBLE]-- they have to concentrate to talk on their phone. So--

ABBY NOYCE: Right. So listening to the radio is just a passive task, whereas talking on the phone is interactive.

AUDIENCE: [INAUDIBLE] active [? with ?] auditory.

ABBY NOYCE: Good. So they've got an independent variable, which is what you have to do while you're driving. And the two levels of the independent variable are what, Natasha?

AUDIENCE: The two components of it?

ABBY NOYCE: Yeah. So remember, independent variables have two levels, they're called. So in our case, it's what you have to do while you're driving. And the two levels are--

AUDIENCE: You have to brake at the--

ABBY NOYCE: The thing they're studying, the thing that they want to find out how it changes people's performance.

AUDIENCE: How does talking on the phone effect your driving?

ABBY NOYCE: That's the question.

AUDIENCE: [INAUDIBLE]. Listening and talking.

ABBY NOYCE: Right. So the independent variable is what people have to do while they're driving. So either listening to the radio or talking on the phone are the two levels of this. They're breaking people into two groups. One group is just going to listen to the radio. One group's going to talk on the phone. And then the dependent variable, the thing that they're measuring is--

AUDIENCE: Oh, I just have a question.

ABBY NOYCE: Sure.

AUDIENCE: Do they talk on the phone to a person that was worth talking to, or--

ABBY NOYCE: I think you had to talk to a friend. And they had assigned topics. One topic was the 2000 Olympics, and the other topic was the 2000 presidential elections. I think they were looking for an effective heatedness about the conversation. But they didn't find any difference between these two groups. So any of the talking on the phone stuff was all the same.

So the dependent variable then is how well they perform on this driving course, right? And they're measuring it by how well people respond to the red signals by breaking. So what did they find out? What do you guys think they found out?

[INTERPOSING VOICES]

ABBY NOYCE: This is one of the classic studies that people who want to get cell phones while driving band tend to cite.

AUDIENCE: Well, if experienced drivers, [INAUDIBLE] decrease all that much. They'd probably get all the brakes because they don't have to actively--

ABBY NOYCE: Think about it?

AUDIENCE: --think about it because they're experienced. Drivers who are experienced talking on the phone at the same time while driving [INAUDIBLE] I don't think their performance would decrease on a brake.

AUDIENCE: It probably would decrease but not so much.

AUDIENCE: Well, since the brakes are only at some interval, they can switch between-- they continue switching between tasks.

ABBY NOYCE: And how to keep monitoring for the brake signal? It's an interesting hypothesis, and certainly what experienced drivers do in other kinds of tasks, tend to do. You're still going to see some amount of decrease in performance when people have to monitor two things like that.

AUDIENCE: It's like when you do a hypothesis test, you measure if there's a significant difference. And is that average difference necessarily a lot?

ABBY NOYCE: Right. So significance and effect sizes are different. So there's a lot of studies showing that women and men tend to be very subtly different in the sorts of things they tend to talk about with their friends, or how many conversations they have with their friends. There's good data. And because people run these studies on 1,000 people, they get differences that are statistically significant. But the difference between the two groups is still really small, or math ability.

You'll tend to see like two overlapping curves that look like this, if those are both normal distributions, right? Good at math. This is Einstein down here. No, not Einstein. Einstein's bad at math. Who's good at math?

AUDIENCE: Me.

ABBY NOYCE: [INAUDIBLE] good at math? This is Einstein down here in the bad at math corner. This is the guy who solved the Poincare conjecture the other year. But the thing is, that here-- and it's really even close in this. I exaggerated it a bit. But even though guys are going to be slightly better at this task, and women are going to be worse, on average, the number of-- let me draw these so that they're actually close because they're not. That's more like it.

AUDIENCE: Yeah.

ABBY NOYCE: So the means are statistically different. But if you take an average woman, a lot of guys are still going to be worse at math than she is. And if you take an average guy, a lot of women are still going to be better at math than he is. So there's slight differences over the group as a whole, but they're not very useful in predicting individuals is really what I'm trying to go with that, that you can get differences that are statistically significant that aren't really very useful in the real world.

You get effects kind of like this with things like different racial groups and, oh, odds of teen pregnancy, where again, the differences are significant because they run the study on 13,000 high schoolers. But it's not useful in any way because the difference is still so small. Back on topic, so we're studying cell phone use while driving.

We are assigning people to either listen to the radio or talk on the phone. They have to drive through this course. And when the signal light flashes red, they have to brake. So what they found is that people in the phone condition entirely missed a break signal twice as much as people in the just a radio condition. And they also found that their response times, how fast the phone conditions subjects responded to that red light and hit the brake was slower than people just listening to the radio.

AUDIENCE: About how much?

ABBY NOYCE: I was lazy and I didn't look up the original study. I can bring it in tomorrow. I don't know how much. I didn't have-- yeah.

AUDIENCE: Well, I think the controversy-- well, it's making people use bluetooth or a headset wouldn't really affect that attentional part.

ABBY NOYCE: That is the big, big part of that argument. Yeah.

AUDIENCE: Because [INAUDIBLE].

ABBY NOYCE: Right. Well--

AUDIENCE: [INAUDIBLE] attentional part that wouldn't really change.

ABBY NOYCE: Yeah. There's something to be said for the fact that just having to hang on to the phone while you're doing everything else is eating some of your attention too. But probably a minuscule part of what's happening and this task has to do with that. Yeah. You get this kind of performance drop off with headsets too. Headsets as a response-- the headset requirements, the hands-free device requirements, as a solution to the fact that you see people get in accidents when they talk on the phone is a-- it looks good. Let's do it. But it doesn't actually solve the problem very well.

AUDIENCE: Also, is there a law against having only one hand on the wheel?

ABBY NOYCE: Not that I know about. I believe that you can get cited for-- it depends. And this varies state to state. At least in some states you can get cited for driving while distracted, or driving like-- this is one of those things where my friends who live in New York call it the driving like an idiot ticket, where like if a cop sees you do something it's just spectacularly dumb or dangerous, they can pull you over, or if you are proven to be distracted in some way, and you get into an accident, your insurance company is-- you're much more likely to be found at fault for the accident, if you're on the phone, or you're eating, or you're bending over to pick up your lapdog off the floor of the passenger seat.

My mom is an EMT in the town where I grew up in. And she went on an ambulance call once when I was probably in middle school. A lady was driving down the main street of the town, 30 miles an hour. This wasn't city traffic. It was nice, empty road. And she reached over to pick up her dog, and she hit a phone call. She was OK, the dog was OK, the car was not OK. But take your attention off the road, and it just goes.

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: I thought this was a spectacularly stupid reason to get into an accident as well. But--

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: Anyway, so the bigger picture to be learning here is that when you are trying to focus your attention on more than one task at the same time, your performance on both tasks is probably going to decrease. So we've been talking a little bit about two types of attention.

There's this kind of centrally controlled top down attention. Another word is endogenous that some people will use. And there's this bottom up stimulus controlled attention where something that's going on in your surroundings causes you to remove your attention from whatever it was previously doing and look somewhere else. When David came in and dropped off the attendance sheets, all you all turned around to see what was going on. That's this exogenous stimulus-driven attention.

AUDIENCE: Wait, when did he do that?

ABBY NOYCE: He did it very quietly. Not everybody saw. But I know that some people over on this side of the room definitely saw him do it.

[INTERPOSING VOICES]

ABBY NOYCE: Attention is interesting. One of the things that's interesting about attention is how good people are at focusing on-- like letting their top down controlled attention trump bottom up stimuli that are pushing in on it. We probably all know people who are really good at studying with lots of background noise going on, and other people who just can't focus if they've got that kind of chaos. And that's, among other things, the difference in your ability to control that centrally-based attention and not let other stimuli grab onto it.

AUDIENCE: So when I do that [INAUDIBLE].

AUDIENCE: Wait, what?

ABBY NOYCE: Yeah. So you're creating a stimulus to get people's exogenous attention. And a bunch of people very carefully didn't look away. Power of willpower. OK. What are we up to? [INAUDIBLE] time. So what is this attention thing? So what's happening when you pay attention to something?

So this guy named Posner, who was one of the classic guys in the field, this was a model he published in the '80s. And he says that in order to pay attention to something, you need transfer it, to shift your attention to a new focus. You need to be able to do three things. You've got to disengage your attention from whatever it's currently focusing on. You've got to point it out whenever you want to focus on next. And you've got to reengage it.

And one of the pieces of evidence that he used for the fact that there are these separate mental operations involved is what happens in patients with hemispatial neglect. So heavy spatial neglect happens in patients usually who have damage to the parietal lobe. Most often, it's damage to the right parietal lobe leading to neglect of the left visual field.

And so if you give these patients a picture of a clock and ask them to copy it-- these there two pretty characteristic examples of a daisy-- ask them to clot copy it. And, of course, the original drawings for both of these had features, had all the numbers all the way around the clock, had petals all the way around the daisy, and leaves on both sides.

And as you can see, these patients pretty much just disregard everything in the left half, on the left half of these objects. They only pay attention to what's on the right half of these objects. So you'd ask them to copy this drawing of a clock, and they'll do that, and they'll hand you one with the numbers 12 through five on it. And you'll say, do you want to make any changes to that? And they'll look at the one they drew, and they'll look at the one they're copying, and they'll say, no. I'm good.

AUDIENCE: So the one on the right, is that because they know a clock has 12 numbers on it, so they try and--

ABBY NOYCE: Maybe, or it might be that their damage is a little bit less severe than the other patients. This is something where you'll see ranges of it. You'll see really severe and milder. He's got more petals on the daisy. He's got a central leaf on the daisy, or she. I don't know. So I would imagine that this is probably just, more than anything, a difference in the severity of the handicap.

AUDIENCE: In patient B there's two 12s.

ABBY NOYCE: That's a good point. I hadn't noticed that. Oh, is that 12, one, two?

AUDIENCE: It's 12, one, two.

AUDIENCE: Why is it--

ABBY NOYCE: Look, actually, if I look at it, yeah, B has all the numbers there. But they're not--

AUDIENCE: [INAUDIBLE] spread properly.

ABBY NOYCE: They're not spread properly. That's interesting. That might-- yeah, that's an interesting hypothesis. I hadn't noticed that. Cool. So patients and hemispatial neglect. So they won't perceive things on the left side of their visual field, as demonstrated in these copies. If you ask them to copy a drawing that shows several objects lined up in a row, they'll copy the right hand side of each one and leave the left blank.

AUDIENCE: And it's not just that they can't see the--

ABBY NOYCE: It's not just that they can't see the left side. For most of these patients, if you put something that is sufficiently salient in their left field, like a giant flashing light or something, they'll respond to that. But they won't respond to it if it's just a little thing. So they can see it. And sometimes if you can direct their attention there, then you can get them to respond to things in the left visual field. You can tell them to look at something over here.

And, again, it varies with the severity of the damage. But in particular, Posner looks at this hemispatial neglect thing and says that what seems to be happening with patients who are in the milder form of this, where they can see things in their left visual field, they don't really want to direct their attention to them. They have a hard time directing their attention to things in the left visual field unless it's explicitly directed there. He says that what's happening is that there isn't-- the patients are having a hard time disengaging their attention from the right visual field in order to move it over, that what's actually is happening is that your attention is staying stuck on. It can't disengage in order to move, so that there isn't something about these patients left visual field isn't able to send the signal to disengage attention in order to start this process of moving it from one place to another.

Oh, we're going to shift gears a little bit and talk about some broad theories about how the attentional bottleneck works, and where in processing your systems decide to, OK, 90% of what's coming in, I'm getting rid of. I'm going to focus on this little bit that is salient, that is relevant for some reason. So one of the big questions here is the classic model of attention is that selection happens very, very early in the processing stages. So sensory input comes in. It's a fire hose of information. It gets processed very basically for things like in the visual system, color, and shape.

And then 90% of it is discarded. And only a little bit makes it on to higher level processing where you're actually trying to make some kind of sense out of what you're hearing. So in this early processing method model, this is where our attentional model bottleneck is, right, between this very preliminary processing and then the higher order content semantic processing where you actually make sense out of this.

So an early selection model would say that if you know you're looking for your friend at a crowded party who's wearing a red shirt, and you're scanning the crowd of people, all of the sensory input is coming in. It's getting sorted by a few basic features, in this case, color. And you're throwing out all of the pieces of your visual field that aren't attached to a red shirt. And then only those pieces are getting looked at more carefully to be like, does this person match my friend?

Some of the problems with this is-- the best one is what's called the cocktail party effect, where if you're in a crowded room with lots of conversations going on and a lot of background noise, and somebody on the other side of the room mentions your name, you're really likely to pick up on that piece of information, even if you totally weren't paying attention to this before, or if you're doing your homework and your roommate in a couple of her friends are gabbing in the hallway and you hear your name, all of a sudden, this stream of input that you haven't been paying any attention to manages to [MAKES ATTENTIONAL SOUND] you're talking about me.

AUDIENCE: Is it really called the cocktail party--

ABBY NOYCE: It is called the cocktail party effect. So this is a piece of bottom up stimulus driven attention shifting, right? You're shifting your attention to this conversation. But it can't just be this preliminary basic early processing that's letting it in because it depends on what the content of that stimulus is. Another good example of this is what's called a dichroic listening study, where you have somebody sit there and wear headphones.

And they've got two different sentences coming in, like one in each ear. So the left ear might be saying-- I don't know-- once upon a time, a long, long time ago, there was a happy princess. And the right ear might be saying, to repair your motorcycle, first you must-- two very two streams of text with very different context.

And if you tell people to listen to just what's in their left ear or just what's in the right ear, they can do that. And they're actually reasonably good at-- they're actually really bad at remembering what's in the other ear. If you ask them what was the other steam? They'll be like, I have no clue. I was only focusing on this one.

But if you switch them halfway through that the left ear goes, once upon a time, a long, long time ago-- first you must disassemble the engine and-- and the left ear goes, to repair your motorcycle-- first, there was a happy princess who lived-- and you tell them to attend to the left ear, they won't hear the ear. They will continue following one of the threads of this, even though which ear it's coming from has switched. So they'll hear only the princess story, or only the motorcycle repair guide despite--

AUDIENCE: Is that even though they're trying to listen to a specific ear?

ABBY NOYCE: No, whichever ear you tell them to listen to, they'll follow the thread of that story, even if you switch it. Even if you switch it back-- and they won't know that it switched. You then said, did you notice anything odd about that? Did you notice that it switched ears? Nope. And so this is another case where which stimulus is being attended to can't just be explained by basic early processing features.

Again, it's really dependent on the content of what's coming in, that you're following a piece of content despite one of its biggest early processing features, which is which ear that noise is coming into just changed entirely. So this whole like early selection attentional model has some big holes in it.

There's a couple of later selection models that we're going to talk about, the first of which is what's called a spotlight theory. And the spotlight theory is a theory of visual attention. Most of these, most of the really well-defined theories are theories of visual attention, partly because more research gets done on vision than on any other modality.

And the spotlight theory basically-- this model's attention is being like a spotlight. Your attention flits around the visual scene and shines on a particular spot. And whatever's in that spot is what you're attending to. It's kind like you being in a dark room with a flashlight. You can only see a very small portion of it at that time.

And spotlight theorists say that when you attend to a spot, that's all. You're just focusing your attention on a particular location, and everything that's there gets attended to. One little flaw with this theory that the reading makes a big deal out of that I don't think it's that big a deal, it says if I have multiple objects, two objects, and I ask you to attend to the water bottle, and then switch your attention to the pile of paper, how long it takes you to switch your attention between these two is the same whether or not there's a third object in the middle that an honest to goodness smoothly moving spotlight would have to hop over. But if we don't think of a spotlight as having to move smoothly, this works pretty well.

A bigger problem is if you ask people to do something, to look at items like this where there is a box and a line, and ask them to do-- it you ask them to do two tasks about the boxes, the box, big or little, and is the gap in the box on the left side or the right side, they can do two-box tasks reasonably well. If you ask them is the line diagonal or upright, and is it solid or dotted, and to respond to both of those, they can do two line tasks reasonably well.

But if you ask them, is the gap on the left side of the box? And is the line diagonal or upright? Then their performance is worse. Even though both the box and the line are in the same location, the fact that they're having to think about two objects, two things that are being registered as separate objects, reduces performance. And so this is evidence that attention seems to be focused not just on locations, but actually on objects. And frequently, objects art in locations, but biding your attention onto an object is different from biding your attention onto a location.

OK, third theory, it's what's called feature integration theory. So I'm going to show you two images. Your mission is to find the black circle. Who sees the black circle in this image? You see it just like that, right? It pops out at you.

AUDIENCE: Technically, that's--

ABBY NOYCE: Not quite circular, is that where you're going with that?

AUDIENCE: No. The circle [INAUDIBLE]. That's the inside of a circle.

ABBY NOYCE: Here's another one. Find the black circle. This one is probably at least a little bit harder. It should take a little bit longer. Not a lot, but if we're having you hit a key when you find it-- and we're measuring your responses in milliseconds-- you will see the difference. What's different about these two [? stimulin. ?]

AUDIENCE: Before, we were just looking for a black, basically, just solid black [INAUDIBLE].

ABBY NOYCE: Right. So a feature identity integration theorist would say, in the first task, there was one feature that differentiated the target from everything else. And that feature was color. And so you could just be like, done. There it is. In this one, there's two features that are distinguishing it. it's color and shape. And so feature integration theory says that these are two very different kinds of searching tasks. This is a visual search task.

AUDIENCE: Could that imply that distinguishing colors is easier than distinguishing shapes?

ABBY NOYCE: No, because if I give you a circle among squares, and they're all the same color, you get those fast too.

AUDIENCE: Oh, OK.

ABBY NOYCE: And the classic example of this is a red X among red O's, or a red X among green X's are both very fast to find. But a red X among red O's and green X's is a lot slower to find because it's being distinguished by two features rather than one. So terminology, the first of those, where we had just the black circle among the white circles, is a disjunctive trial. There's one feature that distinguishes the target from the distracters. The distracters are all the things in the image that are not targets.

The second one is a conjunctive trial, where there is more than one feature that defines the target. And feature integration notes that one of the things that's interesting about this, is with disjunctive trials, where you're trying to find a target that differs from its distracters by-- they're are all the same color and then one's a different shape, or they're all the same shape, and one's a different color, these kinds of single-feature differences, if I ask you to find a target with four distracters and a target with 25 distracters, you're going to be equally fast on both of those tasks.

So people say that disjunctive search is pre-attentive. You don't have to attend to the individual items in the field in order to distinguish the target from the distracters. In a conjunctive trial, where you've got the black squares, and the white circles, and you're looking for the black circle, as I add items to the number of distracters, if I start with three distracters and then test you with four, and then five, and then six, and on up, your performance gets-- your average performance, your average time to find the target gets steadily slower with each one, with each distracter that you add.

So this is an attention required task, where you have to actually attend to individual items until you find the target. So if you were graphing this, and it was like number of distracters, response time-- rt is response time-- so we have a disjunctive trial. That's the black circle among white circles. And your response is going to stay pretty much even, whereas for conjunctive trial, it's usually harder. You're going to start out slower. And as the number of distracters-- this is not the order I wanted to do these in. I'm going to

do this in this order.

That's the graph I'm drawing. Number of distracters-- there we go. That makes more sense.

AUDIENCE: Variable goes on the [INAUDIBLE].

ABBY NOYCE: Yes, number of distracters, reaction time. And as the number of distracters increases with a conjunctivitis task--

AUDIENCE: Is that 0 right there? [INAUDIBLE] 0, would there be a point at 0 for zero distrators? Because you'd automatically know. So it would be a little hole there.

ABBY NOYCE: Well, there's still some reaction time involved, right? We're measuring how long it takes you to press the spacebar that says, yes, my target is in this field. There's no such thing as a zero response. This might be the 75-millisecond line though. I don't know. I don't have good numbers for exactly how long would take. But it's fast.

And the thing that's relevant is that it's consistently fast no matter how many distracters I give you. If I give you 100 white circles and one black one, you're just as fast at finding the black one as you were with 15 others. With conjunctive tasks on the other hand, reaction time goes up, pretty much probably not quite that steeply, but pretty much linearly.

AUDIENCE: Shouldn't this guard the same points since they'd only-- if there are zero distractors, would take the same amount of time.

ABBY NOYCE: Yeah. We're probably not starting at zero. We're probably starting at five or something, something small, three. Reaction time will start at zero. We won't do a cheater graph where we skip the first 300 or something.

But the thing that's interesting is conjunctive trials tend to get linear. conjunctive trials, every time you add a distracter, the amount of extra work you have to do to find that target goes up. And so what people conclude from this is that you have to focus your attention on each item individually in a conjunctive search in order to confirm that it is or is not your target.

So feature integration theorists say that how you do this is your-- we talked last week about how the visual system is modular. Different parts of it specialize in different features. That's not a hugely new idea. And feature integration theorists say that for each feature, you have information about the location of it.

So you have information about color and location over in the color module. You have information about shape and location over in the shape module. You have information about direction of movement and location over in the direction of movement module. And this junctive search is required that you only consult one of these maps. You just say, hey, look, color map. There's the black one. And it goes.

And in a conjunctive search, you have to line the color map and the shape map up against each other and look for the point where you've got both your targets, both your target features, where you've got circle and black in the same location. So you'll notice that like feature integration theory, like spotlight theory, feature integration theory is visual, and it's about attention bound to location in a big way.

This whole attention and location thing works really well when you're talking about visual attention. It works a lot less well when you're attending to an auditory stream, or to some kind of internal imagery. Think about your first grade birthday party. It's not a location bound task. It's an imagery task. So these are some of the big gaps in how people think about this stuff.

AUDIENCE: When it says two, does it mean two or more or--

ABBY NOYCE: Yes, two or more.

AUDIENCE: --or do we only manage to compare two maps at a time.

ABBY NOYCE: No, you can do conjunctive searches that require three. If we take our white circles and black squares, and we add-- I don't know. And if we have targets that are both drifting upwards and drifting downwards on a screen, and we're looking for a black circle that is drifting downwards that's a third feature, and these theorists would say you've got a third map that you're comparing.

AUDIENCE: Do you pair [INAUDIBLE] at the same time [INAUDIBLE]?

ABBY NOYCE: Well, even if you only compare-- in a conjunctive search, even if you compare two of the three, you're going to have multiple potential targets. So you're going to have to--

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: For the third?

AUDIENCE: For the third.

ABBY NOYCE: Yeah. I don't know if anybody has come up with a good theory about what happens in that case about the details of how it happens, or how you would get experimental evidence to confirm one or the other. It's an interesting question. It's a good question.

All right, most neuroscientists who look at attention don't think about attention quite the way that the cognitive psych people do. They say that attention is what happens. You've got different inputs. The inputs compete with each other. And the strongest input gets bumped up, and it gets brought into conscious awareness.

Different inputs can compete at any stage of processing. You can have very early processing competing with very late processing. And exactly what makes an input stronger has a lot of variation. It can depend on what kind of task you're trying to do. It can depend on characteristics of the inputs. A loud bang is probably always going to be a reasonably salient piece of stimulus.

And yeah, this competition theory is how a lot of neural people who look at the stuff like to think about it. Oops, sorry. Go back. Give me a thing. Come on, little laptop. There we go. No. OK, questions about attention, the theories of attention, models of attention? All right.

AUDIENCE: Can you go back to the slide that introduced the spotlight theory?

ABBY NOYCE: I can.

AUDIENCE: About half way through copying down I started listening to you and--

ABBY NOYCE: That's OK. So spotlight theory, again, is this idea that attention focuses on a location in space, that when you attend to a location in space, you tend to everything within this little circle. It's not a great theory, but it's a longstanding one.

OK, the paper we are reading this week is "Covert-Orienting of Attention and Over Eye Movements Activate Identical Brain Regions." I figured we'd read an FMRI study because they're fun. So I'm going to take one, pass them. I'm going to apologize. My printer decided that we need to print stuff so that it flips top to bottom and not left to right because I don't know why. Dan did something to it, and it wouldn't print at all for me for several hours. And then when it did, it did this.

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: Yes. And I'm good with computers, but he's a software engineer, and a network geek, and does this for a living. So he has ownership of our home network. So then he changes things. And then he goes to work. And we were not happy this afternoon.

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: No. My printer's name is Papyrus. It is Papyrus.local.

AUDIENCE: Really?

ABBY NOYCE: Yes. It's a really nice printer. It actually has a web interface. If you go to just type Papyrus into your web browser, then it gives you the controls for it. All right, so this is a first really neuro paper that we've looked at. Oh, come on. None of that. What are you doing? What are you doing?

There we go, the first really neural paper that we looked at. I think these can be a little bit more intense to read. There's usually more new terminology talking about particular brain regions and stuff. Let's take a minute to just-- let's try and read the abstract and make sure we can make sense out of that. And then I'm going to do like last week. I'm going to break you guys up, and have each group have a section of the thing to report on to the group.

AUDIENCE: How long is the abstract?

ABBY NOYCE: The abstract is just the one paragraph right on the first page.

AUDIENCE: Oh, OK.

ABBY NOYCE: So an abstract is usually a couple hundred words summary of the paper. So this is what you read to decide if you actually want to read the whole thing.

AUDIENCE: [INAUDIBLE] investigated the anatomical relationship between [INAUDIBLE].

ABBY NOYCE: OK, so anatomical relationship, so they mean they're looking at what kind of-- when they say anatomy, we're presuming they mean brain anatomy in this case. What parts of your neuro anatomy are involved when you covertly or overtly shift your attention? We think we've got a pretty good grasp of what's involved in shifting attention. What's this covert and overt thing?

So covert, overt attention shifting is like actually moving your gauge, directing your gaze to actually look at a different object in the room. So you could shift your gaze to the screen, or to the graph on the board, and all of these would be overt shifts of attention to new stimuli.

A covert shift of attention it would be you keep looking at the same point. But while keeping your eyes fixated, say, on me, you nonetheless attended to what was happening on the screen, which is hard. We're pretty strongly wired to want to look directly at whatever it is that we're attending to, but we certainly can do it. So you can look directly at me and think about the laptop, or the screen, or something that's a little ways away from wherever you're actually fixating your eyes. So that's a shift of attention that doesn't have a physical moving of gaze that goes with it.

AUDIENCE: What if you keep looking at the same thing, but you're actually concentrating on a different aspect of that?

ABBY NOYCE: A different aspect of the same thing?

AUDIENCE: Of the same thing.

ABBY NOYCE: So that's a shift in attention within the same object. I don't know which of those categories I would put that in. It's not quite-- they're looking at two that are a little bit better distinguished than that. I'm going to talk tomorrow, actually, about some research that the lab I used to work in was doing. And one of the things they're doing is have people attend to different-- not people-- that attend to different aspects of the same stimulus.

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: Overt is the actually moving your gaze around. Covert is the being sneaky about it. Covert operations is spy operations. So it's being subtle about how you're shifting attention. OK, second sentence, who wants to read? [? Zechariah. ?]

AUDIENCE: Previous studies have found that the areas of the brain activated by the covert and overt shifts are [INAUDIBLE] are very similar.

ABBY NOYCE: OK, questions? Third sentence, who wants to read? Natasha?

AUDIENCE: [INAUDIBLE]. There are few issues [INAUDIBLE].

ABBY NOYCE: Jenny?

AUDIENCE: Primarily, [INAUDIBLE] to produce covert [INAUDIBLE] were not always comparable.

ABBY NOYCE: All right, so they're listing off problems with-- other people have tried to look at covert and overt attention to see if they're using the same parts of your brain. And these guys are like, OK, we think there's some good evidence for this, but there's some problems in the previous work. So we're going to try and put together a study that fixes these problems, and tries to prove once and for all that this is really true.

And this is fairly typical. This is trying to reproduce somebody else's results sort of thing that is a really important part of what makes science go, is having results that you can have. You can do the same experiment more than once, get the same results. But on the other hand, it's hard to get funding for an experiment if you're just reproducing someone else's results.

So really frequently you'll see people say, we're going to try to reproduce their results and we're going to fix some flaws in the original study. All right, so not always comparable. So if you're asking people to do different tasks, tasks that are not sufficiently similar, and then you're trying to compare how brain activity is changing, then it's possible that the differences you're seeing are not differences in overt and covert attention shifting per se. They're actually differences that have to do with the original task.

What are you up to? Secondly, [? Naman, ?] can you read?

AUDIENCE: [INAUDIBLE].

ABBY NOYCE: OK, so another change they're trying to-- another thing they're trying to clarify in this study. Wayne, thirdly?

AUDIENCE: Thirdly, the previous studies differed on what are shifts of attention were based on exogenous or endogenous [INAUDIBLE].

ABBY NOYCE: Right, that's that exogenous and endogenous attention that we talked about, the stimulus driven versus centrally controlled attentional shifts. Exogenous, exo, outside, that's a stimulus controlled attention shift. Endogenous is coming from within. It's the internal centrally controlled attention shift. Finally, Jen.

AUDIENCE: Finally, the statistical analyses used by all previous studies failed to account for between subject variability.

ABBY NOYCE: Mm-hm. Do you know what that means? So we didn't talk about this too much when we talked about experiment design, but there's two big ways of setting up an experiment where you want to compare two tasks. And one is a between subjects design, where you've got a group A and a group B, and you measure group A, and you measure Group B, and you see how they are different.

The other is a within subjects design. If you want to know whether people are better at driving that course while on the phone or listening to the radio, you could have, for each person, have them drive the course twice, once listening to the radio, once talking on the phone, and see how each person's performance changes. So that's a within subject study. It's probably a bad example for it. There's a lot of confines.

AUDIENCE: [INAUDIBLE]?

ABBY NOYCE: Matched pair is a between subjects study. But it's a form of counter-balancing to make sure that you don't have a confound where-- I don't know-- all the people in group A come from rich households, and all the poor people in group B come from poor households. And then you have a big socioeconomic factor that's going to be a big problem for whatever, that could be accounting for whatever other differences you're finding.

And if what you're really trying to find is the effects of caffeine on a memorization task, having this total other issue that might be affecting people's performance is bad. So a match pair would say, OK, you take-- if we're looking at socioeconomic, you take two people with even socioeconomic status. You put one in group A and one in group B, and you do the next same thing, and you make sure that they're evenly spread.

So it's more it's more careful than random assignment. With smaller groups, where there's literally a big spread on something like that, is where you're likely to see a match pair paradigm. All right, so previous studies failed to count for between subject variability. So where if person A's pattern of activation is different than person B's is different than person C's, these guys are trying to take that into account in their analysis, and try and come up with a broader, good picture.

All right, the present study was designed to address all these issues. 12 healthy, Helen, do you want to read?

AUDIENCE: Oh, 12 healthy subjects performed either covert or overt shifts of attention are the function of magnetic resonance imaging, MRI-- fMRI [INAUDIBLE] was continuously measured.

ABBY NOYCE: OK, so they had 12 subjects, had them do these shifts of attention, measured the FMRI signal. We talked about FMRI as an imaging mechanism. FMRI tracks changes in blood flow in the brain, which is believed to be good, to correlate really well with changes in neural activity. So it's an indirect measure of neural activity in the brain. What are we up to? In line. [INAUDIBLE], do you want to read?

AUDIENCE: In line with the previous studies, the previous study showed [INAUDIBLE].

ABBY NOYCE: OK, so pretty much the same brain areas are involved in both. Sarah, furthermore?

AUDIENCE: Furthermore, [INAUDIBLE] endogenous [INAUDIBLE] shifts of attention, the study found that the covert shifts of attention resulted in high level activations of the brain than overt shifts of attention.

ABBY NOYCE: Good. So remember, endogenous driven shifts are driven by centrally controlled shifts. You're choosing to attend to one stimulus or another. And those resulted in higher levels of activation. Good. Last sentence. [? Genti, ?] you want to read?

AUDIENCE: The results of this study provide support for the [INAUDIBLE] theory of attention. That posits that the attentional motor systems are the result of neural activation in the same areas of the brain.

ABBY NOYCE: Good. Cool. OK.