Claire: Hello and welcome to Forward Thinking, the monthly podcast where we talk to our academics about their brilliant research ideas and projects. My name is Claire Francis, and today I’m talking to Sarah MacPherson. Sarah is a Senior Lecturer in Human Cognitive Neuroscience in the Psychology Department of the University of Edinburgh. Her main research interest is frontal lobe functions in healthy ageing and damaged brains. She is an action editor for Cortex and Treasurer of the British Neuropsychological Society. Last year she co-authored and published a book, The Handbook of Frontal Lobe Assessment, which discusses the importance of assessing patients using different types of frontal tests.

Claire: Welcome to the podcast Sarah

Sarah: Thank you

Claire: So firstly, what exactly is the frontal lobe, and why do we assess frontal lobe functions?

Sarah: Our brain is subdivided into various lobes and the frontal lobes make up about a third of the brain. And so, it used to be thought that if you damaged that area of the brain that it would have little impact on your abilities. If we think of the most famous case of frontal lobe damage, many people will have heard of Phineas Gage, who was a gentleman in the late 1800s who had an accident where a tamping iron entered his cheek, went behind his eye and out through the top of his head and damaged both his frontal lobes of the brain. Because he was very soon up and about, walking and talking - he was able to go onto the cart that was going to take him to hospital - people thought that damage to the frontal lobes of the brain had little impact on your abilities. At the time, the American Phrenological Society had argued that it was unlikely that you could have damaged that part of the brain, without having several of your cognitive abilities impaired. But it wasn’t for twenty years that the doctor who had been seeing Phineas Gage reported that in actual fact, he was no longer Gage. He had changed, he had severe personality changes, he became more outgoing, he was very stubborn, he would tell jokes and use language that was quite inappropriate, and so he had changed severely in his personality.

We know now that damage to the frontal lobes, if somebody has damaged that area, that they can have severe changes in their personality. But we also know that a number of other cognitive abilities can be impaired. One aspect of cognition which is often impaired in patients with frontal lobe damage is their executive abilities. Our executive abilities are our higher order cognition, so our memory, our language, our attention, and so on. People who have damage to their executive functions can have difficulty in their everyday life carrying out everyday tasks like running for errands, cooking dinner...people who have had damage to the frontal lobes, let’s say due to a head injury, or a stroke, or a brain tumour, may have difficult carrying out these everyday tasks. So there are a number of abilities we now know are associated with the frontal lobes of the brain, that if somebody has damage to that area, these abilities can be impaired.

Claire: And what tests are currently used to assess frontal lobe functions?

Sarah: In the clinic and in research people tend to focus on executive dysfunction, so these higher order control functions, probably because these tests already exist; they have normative data for them, so they have been administered to the healthy population to see how they might perform these tasks. So we have normative data where we can predict how somebody should - at a particular age, gender and years of education – perform on these types of tasks. And so in the clinic, we can
use these types of tasks, they might assess people’s ability to plan, people’s ability to inhibit inappropriate responses, people’s ability to switch between different tasks; these are what are typically used to assess people in the clinic.

Claire: And your book discusses the importance of assessing patients using different types of tests, why is this important?

Sarah: I think currently, within the clinic, because people don’t have a lot of time, or only certain tests are available to them, that they will only administer perhaps one type of executive function. So they might assess something like planning or they might administer a task that assesses the ability to switch between tasks. However, we know now that the executive abilities can be fractionated into different types of executive dysfunction. So just because somebody performs well on one aspect of executive function, they may fail another. So by only administering one executive task in the clinic or in the lab, we might think that somebody’s executive abilities are intact, when in actual fact another aspect might be impaired.

So more recently, tasks have been devised such as the Multiple Errands task, was probably one of the earlier tests that was devised to assess more real world executive abilities. It was devised by Professor Tim Shallice and Professor Paul Burges where they would have a pedestrianised street in London and individuals would have a series of tasks that they would have to achieve. So they might have to go and buy a particular item from a shop, they might have to find a piece of information, and they would have certain rules that they would have to follow such as only go into a shop if you’re going to buy something. And when patients do these kinds of tasks they perform them less efficiently than you or I might do. And so, I think it’s important to assess these different abilities – so, executive abilities, executive abilities in the real world, but also some of the social cognition measures, so we get a full picture of how the frontal damage has affected individuals.

Claire: What kind of research did you undertake in the writing of your book?

Sarah: The idea for the book came from my PhD, which was the late 90s and early 2000s, so at that point, we thought that writing the book was a good idea, this was because at the time, my PhD was looking at the idea that the frontal lobes of the brain are one of the areas of the brain that the neurons, or the brain cells, deteriorate much earlier and more rapidly than some of the other areas of the brain. And so older adults have deterioration in the frontal lobes of the brain, however patients, as I’ve said before, who might have damaged the frontal lobes of the brain, they might perform well on some executive tasks in the clinic, but perform poorly in the real world. In contrast, older adults were performing poorly on some of these clinical executive tasks but were performing – anecdotally, perhaps – well with the real world. And so at that point I was interested in looking at how the frontal lobes – it’s a large area of the brain – it’s likely that different sub-regions of the frontal lobes have different functions. And so some of the evidence from the literature suggested that the cells in different sub-regions of the frontal lobes, the cellular structure, was different; the connections with other brain regions was different; and perhaps the functions of these different frontal sub-regions was different.

At that point I became interested in the idea that the functions of the frontal lobes might be fractionated into different types of functions, depending on which area of the frontal lobes was damaged. At the time, me and my supervisor, Sergio Della Sala, had the idea for the book but just didn’t have the manpower to do it. And more recently, some of my PhD students (Simon Cox, Matthew Eaveson and Alessandra Gheradi) were interested in frontal functions and so between the five of us, we managed to carry a large scale literature review, looking at these various types of
literature; the patient literature, the neuro-imaging literature, and the ageing literature, and managed to put together this book.

**Claire:** And as a result of that review, does your book advocate for a particular testing method over another?

**Sarah:** So I think it’s important for clinicians and researchers to be aware that different tests thought to tap the different frontal lobes of the brain might be assessing different functions, and might be tapping different areas of the frontal lobe. I would advocate for assessing multiple executive functions, if possible, but if clinicians or researchers are limited for time, assess executive functions but also look at perhaps some social cognition measures.

**Claire:** And what would be the outcome, then, of using the different types of frontal tests, for patients?

**Sarah:** Well I think, with patients, if they have damage to the frontal lobes and have impairment of some frontal lobe functions, this can have a huge impact on their lives. It can have an impact on how they interact with their families, their friends, their social interactions, whether they can go home and live independently, whether they can go out and go back to work after they’ve had a stroke or a brain tumour...and so it’s important also for whether or not recommending a patient for rehab, might they benefit from rehab and if so what type of rehab. It is important that we understand the whole profile of spared and impaired frontal abilities that these individuals have, in order to understand whether they might go home and live independently, or whether they might be referred onto other services.

**Claire:** Thanks so much Sarah for talking to us today. If you want to find out more about Sarah’s research, follow the links at the Forward Thinking blog, and if you want to hear more podcasts like this one, subscribe to Forward Thinking.