AT: Welcome to the Infinite Women podcast. I'm your host, Allison Tyra, and today I'm joined by Jess Bugeja, a CERC postdoctoral fellow in CSIRO's Australian eHealth Research Centre, Neurodevelopment and Plasticity team, to talk about Dr Marian Diamond. Why don't we start with why Dr. Diamond was considered one of the founders of modern neuroscience?

JB: Yeah, so I think that's really all to do with the term neuroplasticity. So she was the first person that thought up the term where the brain is actually able to grow and adapt, to be able to absorb information and apply that in the future. So she looked into enriching the environment for children, particularly with toys and companions, in a way that we were actually able to change the anatomy of their brain. So the implication of this was that the brain benefits from an enriched environment.

AT: And there was also a physical movement component as well, right?

JB: So the brain needs to actually have your body to be active, and it will perform better if it is. Vitamin D, so being out in the sun has actually been shown to improve our cognitive function as well. So I think all of those things are really the variables that can improve the way we perform in our daily life.

AT: So actually getting off my couch and going for a walk is more important than I wish it were.

JB: Yes, yes, it is beneficial. (laughter)

AT: And her work has been highly influential, not just in the research that she herself published. But obviously science is a field where everyone else is building on the work of their predecessors. So what are some of the things that have come out of other people building on her research?

JB: The first one that I'm thinking of is the growth mindset. So that was by Carol Dweck. And it's really based on the thought that if you believe that our intelligence and talents can be developed over time, that's rather than thinking that it's just fixed, and we can never change anything. So I think that's a nice connection back to that neuroplasticity. The next one would be the marshmallow test. So this is looking at the thought that self-control can actually be resulting in better outcomes. So this was a nice little experiment, actually, with marshmallows, where the child, for more than 40 years over and over again, the groups were waiting patiently for a marshmallow, and they would succeed more when they had that delayed gratification.
A further one would be Spark by John Ratey. And that's looking into the mind body connection. So this is research that proves that exercise is our best defense against many things, including depression, ADD, addiction, depression, to menopause, and also, Alzheimer's. And I think that's a really nice thing to look into. And the last one is Grit. So that's by Angela Duckworth, and that's defining it as passion and perseverance for long-term goals. That has a nice connection back to the marshmallow test, I think, with Walter Mischel.

AT: And so beyond academia, which obviously she did groundbreaking work, but even outside of that, she really did work to ensure that there was a practical benefit from her findings for people and animals all over the world.

JB: Yeah, yeah, definitely. So her ideas and her efforts for education promoted early nurturing and educational enrichment of children all over the world. Her personal efforts led to the building of orphanages worldwide and focused on enriched environments for impoverished children. Her work, also on environmental enrichment, led to significant improvements in laboratory in zoo animal care.

AT: So basically, if we're not bored, we're healthier.

JB: Yes, yes, it's good to have an active brain.

AT: It's also interesting to note that she was the first woman science instructor at Cornell University, where she taught human biology and comparative anatomy from 1955 to 1958. She was also one of the first professors in her field at the University of California, Berkeley, and she started there as a lecturer in 1960. But one thing that struck me when I was looking at her story was that she completed her PhD the same year she gave birth to her first child, in 1953. And then she started teaching at Cornell the same year she had her second child in 1955. And that's just really unusual because a lot of the women I read about, having kids just ended their careers, so she must have had some form of like childcare support that most women didn't have at the time and I feel like that's something we don't acknowledge as much when we're talking about both, both historically and today?

JB: Yes, 100%. I have to agree. I think it's a very challenging role that women do succeed in their careers with also the family commitments they have.

AT: More commonly, she did definitely experience sexism. And there was a story that she recounted where, obviously, she was one of the first scientists to say that the brain can change and can adapt. And so she was fighting against the status quo. And at a meeting, she recalled that a man stood up after her talk, and said, loudly, “young lady, the brain cannot change.” (laughter)

JB: Yes, I've actually had similar experiences to that in my career as well. So I think it is quite common for females to have that pushback from their male colleagues. Quite early in my career, I was told not to take on an engineering or science based-career because I don't have the mathematical brain that males do. But I think it just made me push harder to actually get there. Because that was that was my goal.

AT: And I think anytime anytime you're pushing back against the status quo, there is always push back from the status quo, like the people who benefit from how things are, and don't want to acknowledge that they may be wrong.

JB: Yes, yeah.

AT: But her career also was incredibly long. Like she was working for about 60 years, publishing influential research well into the early 2000s. So she was in her 70s. At that point, she didn't actually retire until she was 87. And, unusually, for most of the people I talk about just because of timing, she was an internet sensation. So her YouTube Integrative Biology lectures are the second most popular college course in the world in 2010, according to a New York Times article from that year.

JB: Yeah, that's incredible.

AT: And so one of the things she's known for is studying pieces of Einstein's brain in 1984. And I mean, for me, this is very weird and sketchy because Thomas Stoltz Harvey, a pathologist, literally stole Einstein's brain during his 1955 autopsy. He spent three months slicing it up, and later gave pieces away to researchers, and he was just never held accountable in any way for literally stealing the man's brain.

JB: Yeah, Einstein's family let him keep it as long as it was used for medical purposes. I think that's very interesting.

AT: Dr. Diamond found out that certain parts of his brain were found to have a higher proportion of glial cells than the average male brain. So what does that mean in a neuroscience setting?

JB: Yes, so glial cells are consist of what's known as microglia, astrocytes and oligodendrocytes cells, and actually make a really large amount of the mammalian brain, and were originally thought of as non-functional neuronal glue. So I think this is a really interesting part. So astrocytes are actually the most abundant and largest glial cell in the central nervous system. And we've recently found that they actually play a critical role in synaptic transmission. So this is where our neuron cells communicate with each other. Neuroplasticity, which we've spoken about a bit where the brain changes through growth and reorganization to absorb and retain new information, as well as neuro protection and maintenance of the central nervous system. So for example, where debris is cleared from the brain and inflammation is modulated. And I think what's really interesting and, in fact, the connection to what I currently look into, is that astrocytes have been identified to be essential contributors to information processing and cognition. And so I currently work at the intersection of neuroscience and neuroimaging, and we look at investigating preterm neonates' brain macro and microstructural, using magnetic resonance imaging to identify associations with later cognitive outcomes and this includes language memory and behavior. And we have found that previous research has identified that maternal education, socioeconomic status, sex gestation, gestational age at birth, postmenstrual age at magnetic resonance imaging, early brain injury, regional brain volume, brain volumetric growth, and brain shape are all associated with these later cognitive outcomes. So we want to use these variables and potentially others that have also been associated with cognitive outcomes to be able to predict them at two years or maybe even six years for children at that school-ready to age, using just that information collected at birth.

AT: Wow, that's awesome.

JB: Yeah, I'm really excited to see what we can find.

AT: My understanding is that the brain is more plastic when you're younger, so things like learning languages is easier when you're a kid. Yeah, it seems like really getting in early is key if you want to produce the best outcomes for people.

JB: That's exactly right. And that's really what we want to do. So a lot of, particularly motor-related conditions, so for example, cerebral palsy, will be diagnosed, when we actually see those motor deficits, and it's a bit harder to be able to help them out to correct them, because the brain does become less plastic as we get older. So we want to be able to know which babies might develop those problems. And we want to be able to help them earlier so that they can have a better quality of life with better outcomes.

AT: I'm just looking at the list of factors that you mentioned. And it's really fascinating to me that things like you mentioned maternal education. So in that case, it's not just you know, nurture versus nature, it's nurture of the parent that is impacting nature of the child. And I know this is a huge question. But have you learned anything about the mechanisms like how it actually works?

JB: That is a great question. I think it is multifactored. So it wouldn't just be because the mother might have a higher education potentially, that her level of education will influence the way she behaves around the child. So if a mother is more nurturing, if, in fact, something that we've just heard recently, a mother with a more melodic voice, can actually affect the way the baby is able to respond to a sentence structure. So I think that's very interesting. So we can actually measure like brainwaves using EEG. And we see that there's actually an alter in the brainwaves when the structure of the sentence is not correct. So I think that's, that's pretty cool. So a baby who can't speak, can actually identify if that sentence doesn't make sense. Another one, a big factor, so gestational age at birth. So if a baby is born too early, the brain hasn't actually completed its development. And it's a little bit harder for the brain to come to that correct stage, or maybe not so much correct. But that old enough that typical age brain, the development is potentially more difficult once the baby is already born. So we need to try to nurture those babies more to be able to reach their greatest outcome.

Age at magnetic resonance imaging, so I think that one's a little bit of an interesting one. And we believe that it might actually be because the babies who have a later scan, they might have actually had more complications earlier in life. And that's why we had to take an earlier scan. So it's not the scan affecting their cognitive outcome. It's the period of time that we had to wait to be able to get this scan that we would assume as why they might have delayed cognitive outcomes that might be poorer.

AT: So what I'm hearing is that some of these factors are probably correlation rather than causation. So with the MRI, but also, going back to the maternal education, it's not that mom having a PhD is inherently causing this, but the correlations of things like, people with PhD more likely to have come from a privileged background, and all the benefits of that has.

JB: Yes, yeah, no, you're definitely correct on some of them are more correlation. Definitely that education, one, the socioeconomic status, so people with a higher socioeconomic status might have more access to greater healthcare. So they might be able to help out their babies more. Some other ones, like, for example, early brain injury, I'd say that one would be more causation. So if we do have damage near out brain, it could definitely affect those areas that are more linked to cognitive outcomes, as well as regional brain volume. And I do wonder if that is also something that Einstein may have had as well as those larger number of astrocytes, potentially had greater regional brain volume in areas that are linked to cognition. And one interesting one that I think that we are trying to explore further now is the brain shape. So the brain is sort of like a wiggly mass of curves and dips. So we want to know if those curves, the depth of those curves thickness of the brain is all linked back to our future cognition.

AT: I feel like I heard once that the wrinklier or your brain is the better - is that, did I just make that up?

JB: No, no, it's definitely true. So babies actually have much smoother brain. So babies that are born quite early, so say between that late 20-week, to quite early 30-week mark, their brain isn't, it doesn't have all those lumps and dips, it's quite smooth. And as we get older our adult brain gets more of those curves more of those dips and that's that's how we develop through our life.

AT: Join us next time on the Infinite Women podcast and remember, well-behaved women rarely make history.