118 | Ecological Validity & Digital Technology – with Dr. Maureen Schmitter-Edgecombe

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NAVIGATING NEUROPSYCHOLOGY

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Speakers: Maureen Schmitter-Edgecombe, Ryan Van Patten, John Bellone

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Intro Music 00:00

John Bellone 00:17

Welcome everyone to Navigating Neuropsychology, a voyage into the depths of the brain and behavior, brought to you by INS. I'm John Bellone.

Ryan Van Patten 00:25

And I'm Ryan Van Patten, and we are board certified neuropsychologists. Today we give you our conversation on ecological validity and digital technology with Dr. Maureen Schmitter-Edgecombe. Maureen is a Regents

Special thanks to Hunter Holoubek & Shanna Cooper for transcribing this episode.

Professor and H. L. Eastlick Distinguished Professor in the Department of Psychology at Washington State University. She is a researcher with over $20 million in grant funding, and she's primarily focused on understanding and improving real world functioning, which we cover with her in depth.

John Bellone 01:01

Note that the INS neither promotes nor recommends any commercial products or services discussed in this episode such as Maureen's book, "The Neuropsychology of Everyday Functioning." And with that, we give you our conversation with Dr. Maureen Schmitter-Edgecombe.

Transition Music 01:24

Ryan Van Patten 01:26

All right, we're here with Maureen Schmitter-Edgecombe. Maureen, thanks for making the time.

Maureen Schmitter-Edgecombe 01:29

Yeah, thank you for having me.

Ryan Van Patten 01:31

So let's start with ecological validity, or the degree to which our tests and evaluations generalize to daily functioning and real world settings. People sometimes talk about two facets of ecological validity: verisimilitude, or the degree to which a cognitive test or assessment method resembles the real world task in question. This is similar to face validity. And verticality, or the degree to which test data statistically predict real world performance? So talk to us about the importance of ecological validity and neuropsychology.

Maureen Schmitter-Edgecombe 02:07

Ryan, that's a great question to start with because neuropsychologist are often asked to answer questions like, "Can my loved one manage their medications or manage their finances or live independently?" And our answers to these questions have important implications for decisions like an individual's diagnosis or their treatment, or even their level of autonomy. And therefore, it's really important for us as neuropsychologists to demonstrate that our tools being used have ecological validity, that they can speak to how a person may be performing in their real world environment. And for neuropsychologist, ecological validity doesn't apply so much to the test itself, as much as to the inferences that we're drawing from those tests about our patients.

John Bellone 02:58

What are some of the challenges involved with predicting real world functioning from our neuropsych tests, just to start things off?

Maureen Schmitter-Edgecombe 03:05

Yeah, I would say these challenges probably fall into three categories. So the neuropsychological tests themselves, the testing environment, and then a host of other factors. So if we start with the neuropsychological test, our tests were not designed to predict how individuals actually perform in the real world environments. So they were originally developed to answer things like lesion localization or level of brain impairment. And they do a great job at telling us about the intactness of varying cognitive abilities. And then it's from there that we then infer how a person's doing in their real world environment or their functional status. And if you think about most everyday tasks, many are very open ended with more than one path to completion, so they might require multitasking, and use multiple cognitive abilities all working together. But most of our neuropsychological tests are designed to assess capacity in one domain, like memory, for example. And then if you think about the common constructs that neuropsychologists often assess, these might not always map on to the types of constructs that are really important to supporting everyday functioning. So things like perspective memory or temporal order memory that might be important for cooking or remembering to take a medication. If we move on to the testing environment... You know, when we're testing in a clinic, there are no distractions, the neuropsychologist is providing the structure. The individuals can't use cues or compensatory strategies that they might use in their real world environment. And we're really only getting a brief snapshot of behavior. And so maybe an individual can rally in clinic, but has more difficulty, you know performing in the real world over longer periods of time. In terms of other sorts of factors, people differ in the daily activities that they engage in, and the methods of engagement. So for example, you know, some people drive, some people take public transportation, some people use a checkbook, other people use automatic bill pay. And for us, as neuropsychologists, you know, we may be being asked is the person able, or their cognition adequate for what they actually need to be doing in their everyday environment. And then if we think about everyday functioning, our meta-analysis suggests that cognition only accounts for about 20 to 25% of the variance in everyday functioning. So there's lots of other factors out there that clinicians need to be thinking about. Things related to the environment, culture, health, personality, physical function, education, literacy. As one example, let's think about the amount of cognitive resources that might be needed when you're driving, say, on a rural road versus in the city when there's lots of congestion, or, you know, if all of a sudden it starts raining, and it becomes a dangerous situation,

John Bellone 06:30

I often... so there's a lot there that you said, and this is a challenging thing for a neuropsychologist to assess for sure. I often have the experience that somebody comes in and does well on my tests, even though they're noticing significant symptoms at home. And I have to remind them that this environment, this testing environment is different from their home environment. And in your book, you write about the difference between ability and function. So someone might have the capacity, the ability to perform a certain task or activity, but then not carry it out, it's not actually be able to do it in their own home environment. So, you know, there is a lot, lots here to talk about. Before we kind of move on and talk about specific digital technologies for

real world assessment, can you give us an overview of different methods for evaluating real world skills? I'm thinking of traditional tests of cognitive functioning, like you alluded to. You also alluded to performance-based tests. And there's also patient and informants-based questionnaires of functional status, various structured and unstructured naturalistic tasks. Can you just give us a general overview of the advantages and disadvantages of these methods?

Maureen Schmitter-Edgecombe 07:42

Sure, traditionally, when neuropsychologists talk about real world skills, they're usually measuring common activities of daily living. And these can range from things like basic activities, like bathing or grooming, to more complex skills, such as cooking, or managing medication or finances, or even using technology, or preparing to travel. So you mentioned questionnaires, and questionnaires are the most frequent method used to assess everyday function, probably because their time and cost effective. And questionnaires can allow the reader to take into account multiple observations of an activity in varying situations. So you know, think about cooking, an individual could draw on multiple examples of where a person might be cooking with the microwave, or the stove or in a client environment or in a distracting environment or when they're cooking for themselves versus multiple people. So there's multiple observations that they can draw on. The biggest drawback to questionnaires is the subjective reporting format. And so that can reduce reliability due to bias. So first, we have people having to think back about their performance, maybe you know, a week ago over the last month, or even the past couple years, and second, variables such as a person's own insight, if they're experiencing anxiety or depression, if we've got caregiver burden, executive dysfunction, all of these things could lead to a person either overestimating or underestimating someone's functional status. Also, when using questionnaires to assess everyday function, if a person has accurate insight, then self-report may be appropriate. Otherwise, it might also be important to get informant-report. But currently, we don't really have any method of deciding, you know, aside from our clinical judgment about whether you know, an informant or the self is a reliable reporter of what's happening in a person's everyday environment. In terms of neurocognitive test, we discussed earlier that most traditional tests weren't designed to measure everyday behaviors. And what they do is they tell us about basic skills that are required in those everyday behaviors. So such as executive functioning, and then from there, we infer how a person may be doing in their everyday environment. So we have a couple of steps there to everyday performance. And that's where performance-based measures come in. Because these are really analog tests, like having someone tie their shoes or fill a medication dispenser, or even, you know, demonstrate some sort of computer awareness by filling a prescription online, all the way through to performing tasks in more naturalistic environments. So unlike our traditional neurocognitive test, Ryan, you talked about very similar to before, here, we're talking about the degree to which the task reflects the demands of what a person might do in their everyday life. And the thought is, if we're having people do tasks that closely approximate what people do in their everyday lives, then there's less of a leap, right, from what they're doing in the lab to what they're doing in the real world environment. The important thing here to remember is that face validity alone does not equal ecological validity. So just because they look like real world tasks, we still have to demonstrate that they can predict functioning in the real world environment. Advantages of performance-based tests include things like they're objective and they're standardized. And they have some fairly well developed psychometric properties, so we can evaluate where people fall relative to others and we can also look at change over time. Some common types of performance-based tests include things like problem-solving tests or behavioral

simulation tests. So an individual might be presented, for example, with a scenario about baking or about medications, and then asked to answer some questions based on that scenario. Or the individual might be asked to simulate in the lab, some real world tasks, such as writing a check, and then addressing an envelope to mail that check, or balancing a checkbook or making change. Internet navigation tasks are another type of performance-based task that some individuals have started to use. And the idea behind these is to get at more advanced kind of computer technology skills. So people might be asked to purchase an airline ticket on the internet or shop online or look up some sort of health information. And one of the exciting things about these measures is that the data can be automatically collected, a lot of data, as the person is completing the task, allowing for, like, a more nuanced understanding of their performance. And one of the other points that I think these type of tasks make is they remind us that when we're evaluating everyday functioning, we need to keep up with these changes in technology and modern living. So you know, asking people things like, you know, how well do you use a telephone book, you know, which was done in many of our older everyday functioning questionnaires is no longer relevant. And so we need to make sure that we're asking everyday questions that are relevant and do match the types of things that people are doing in their everyday lives. Even other newer approaches are things like virtual reality, and here we're trying to simulate right, but the real world, and advantages with virtual reality is the fine grained detail that can be captured as the person is completing this, this task. Probably the best well known virtual reality methods have come with driving, especially when approaches like on-road assessments might be time consuming or even dangerous. But even here, it's important to keep in mind that virtual is not synonymous, again, with ecological validity. And in fact, there have been a number of studies where people have given virtual reality kitchen tasks, and then tasks, similar tasks in a kitchen. And some of these have found correlations between the two tasks, but others have not. So... can I just... I have some more points, can I just keep going?

John Bellone 14:34

Yeah.

Maureen Schmitter-Edgecombe 14:34

Okay.

John Bellone 14:35

I think this, this demonstrates just how many ways there are to assess ecological validity. There's not just one way. I think it's important for listeners to know there's not, you know, it's not just performance space there are manifest functions too, like looking at driving records and looking at medical records and things. I mean, there's so many different ways so yeah, yeah, please continue though.

Maureen Schmitter-Edgecombe 14:54

Okay. So I think like one question that comes up when using performance-based tasks is whether they should be adjusted for factors like age and education. And this is, you know, something that I wrestle with. And I think there's research to suggest that when the task is one that all or most adults should be able to perform, then it's probably best to be using the raw or you know, unadjusted scores. When we're trying to predict reward behaviors, as the difficulty of our performance based test increases, the tasks end up becoming more test-like, and then they show greater correlations with things like education and intelligence. And if you think about it, it's actually quite difficult to develop a measure that's going to reflect what most people should successfully do in their everyday lives. But it's still challenging enough to show us, like, that variability on a normal continuum. So there are some disadvantages to our performance-based tests. Currently, we don't have any sort of consensus measure of you know, what tests would be best to use. We're administering those tests at a single time point. And they may not always reflect what an individual does in the real world environment, right. So if I give them a check writing task, but they actually use online bill pay, then I may not be come close to actually predicting what they're doing in their real world environment. And the biggest thing is, it's important to keep in mind that performance-based tests are not synonymous with ecological validity. And so they still need to be held to the same standards that our traditional paper and pencil tests are held to. And I think we also need to show that if we are using these measures that they actually provide incremental validity, they give us something above and beyond our, you know, other clinical measures.

Ryan Van Patten 16:55

So let's get into naturalistic tasks in more detail. John had mentioned these four different categories. And I think we as neuropsychologists know a good amount about three of them. We know about tests of cognitive functioning, we know about self-report questionnaires, or informant-report questionnaires. And we know quite a bit about performance-based lab tests of activities of daily living like the Texas Functional Living Scale, the ILS, the UCSD Performance-based Skills Assessment. There are others. But you have written and done research in these different naturalistic tasks in realistic environments, and neuropsychologists don't know as much about this. So for example, you co-authored a 2017 review paper and TCN with Kayla Robertson on this topic. In the paper, you described vocational kitchen, store, and hospital and home-based tasks. So for listeners who aren't familiar with what we're talking about with these naturalistic tasks in realistic environments, I'd like to hear you talk more about what they are, the theory and rationale behind them, and then specific examples of what they look like. And also as you had referenced, their psychometrics and clinical utility.

Maureen Schmitter-Edgecombe 18:07

Yeah, um, well, naturalistic tasks are another type of performance-based task. And we ended up using that term to kind of separate this idea that we were talking about tasks that were being performed in naturalistic or simulated environments that mimic the real world environment. So you mentioned, like a kitchen or an office space. And the idea is that because they are performed in a naturalistic environment, they may help to reduce the amount of abstract thinking or imagination that might be required if you're having a person complete a performance-based task in the lab. And many of these tasks typically provide some level of structured roles to help guide performance and then allow for objective and standardized scoring. The tasks are usually open-

ended enough to allow for multiple paths to activity completion, similar to what we might see in many real world situations. And the thought is that because the tasks are performed in a contextually relevant environment, they may help neuropsychologists address questions about functional abilities more accurately, because the task mimics commonplace activities in an environment that more commonly resembles what a person is doing or might encounter in their everyday life. These tasks also allow individuals to code aspects of performance that maybe we don't typically code such as strategies being used. So are they engaging in the task planning? Are they double-checking their behavior? What types of errors are occurring? Are there rule breaks, are they you know, omitting things. Are there off-task behaviors present? And then the idea would be that this information could help us better clarify the nature of real world difficulties, and then ultimately help us better target interventions.

Ryan Van Patten 20:12

Two features of these naturalistic tasks that stand out to me that you've referenced, one is the contextual piece. So they are not performed in a lab space, you know, we can't just use our regular neuropsych room with a table and two chairs and cook this up. It's in a kitchen or it's in a simulated, you know, home space. So right there, you're already closer to the real world. And then the other piece is, they are less structured, you know, we get a lot of benefit from structure in neuropsychology. It's easier to standardize our procedures for cognitive tests when they're structured. So we do a lot of that. It also makes it easier to score a test when you have... when it's a little bit more fixed. But as you had referenced in the real world, there's not somebody following around one of our older adult patients, giving them structure about how to make a meal, make spaghetti, or something... that they're... it's very open ended, so the naturalistic tasks resemble that more. I'd like to get into a few of them to give our listeners a picture of what these look like. So from what I've seen, the Multiple Errands Test has some of the most empirical support of all these naturalistic tasks. So tell us about it was it look like?

Maureen Schmitter-Edgecombe 21:29

Yeah, you're correct. So the Multiple Errands Test, as you said, is probably the best known. It was developed more from this function-led approach. So thinking about what people actually do in their, their everyday lives. So the way that it works is individuals are taken to a shopping center setting, or at least the original version of the MET, because as you discussed earlier, you know, there's cost and a lot of things involved in taking person to a shopping center. And so there's been hospital versions of the MET that have made, there have been virtual reality versions of the MET have that, have been made too. But in the original MET, participants are given an instruction sheet and asked to complete a number of different tasks such as buy a loaf of bread while following a set of rules, such as you know, only enter a shop to buy something. And then what the researchers are able to do with this is really watch the individuals' approach to the tasks and look at things like rule breaking behaviors: are they leaving things out, are they forgetting to carry out things prospectively? And then this can provide a little bit more nuanced information about the types of struggles a person might be having in their real world environment. And they, they have quite a bit of data that does show that it's successful at distinguishing between different types of patient groups too. And we'll get into some of the questions related to demonstrating ecological validity, I think in in a minute, because there's, there's a lot involved there.

John Bellone 23:16

Tell us about... you had developed the day out task and the night out tasks. Can you tell us a bit about those?

Maureen Schmitter-Edgecombe 23:24

Yeah, so the day out task was developed in the tradition of the multiple errands task, and it's completed in a university apartment. And in our case, that apartment also had sensors in it. So initially, the task was created because we were working on activity recognition. And we were using scripted tasks to determine whether we could use the sensors to say when a person was doing things like watering plants, or cooking, or cleaning. And one of the questions that came up is, well, yeah, in everyday life, most people don't just do one activity at a time, there's a lot of multitasking that goes on. So then we decided we needed to develop some sort of task that would allow us to see if we could pull apart these different activities with the sensors that people might be doing when they were multitasking. So that's how the day out task was born as a combination of trying to answer this question with sensors, and then trying to come up with something that would be sensitive also to the early stages of cognitive impairment by creating something that was more open-ended and function-led, like the multiple errands tasks. So the person is given a scenario about things that they have to complete for a day out, and then they have to go about completing eight different sub-tasks to prepare for this day out with their friends. And this includes things like gathering the amount of change... determining and gathering the amount of change they need for a bus ride, microwaving a heating pad for three minutes, remembering to call their friend just before they leave home. So the individuals are told that they can multitask and interweave the task in a way that feels natural and efficient. And when completing the DOT, participants really have to prioritize; they have to organize and initiate different sub-tasks; they have to decide for themselves when they're going to realize the number of delayed intentions and when both the sub-goals and the overall task is complete. In our case, why the participant is completing the task, the examiner is actually upstairs, watching through a series of cameras, and then documenting what the person is doing in real time into our real-time annotation system so that we can tag the sensor information with exactly what the person is doing and any sort of errors that they're making. We then created the night out task after finding that the day out task showed some differences between groups on overall measures like accuracy and time, as well as on a number of process-oriented measures like sequencing and efficiency errors. And because of some of the difficulties that you mentioned, Ryan, earlier, about, you know, less control in a real world environment, you know, the cost, who's going to have access to this real world environment, we wanted to see if we could then take this principle back into the clinic. And so what we did was we created the night out task, which can be done in the clinic and uses props, but still requires the participant to complete eight different sub-tasks while they're getting ready for a night out. And again, the task involves, you know, multiple cognitive abilities. So the multitasking, the planning, the goal-monitoring, the problem-solving, perspective memory. So basically, it's an ill-structured everyday task. Now, another unique aspect of the NOT is that we actually have a tablet interface that allows us to track performance in real time. So as the person is completing the task in the clinic, we can easily start and stop when they're starting a certain task, stopping it, moving on to another task. We can code the different types of errors that they're making. We've started coding different strategies that we think might represent compensatory mechanisms, such as how much time they

might be spending and things like mid-task planning, or if they're not doing a lot of multitasking, or if they're doing a lot of double-checking behaviors, and really trying to, in the clinic, see if we can create a situation that would allow us to understand at a more nuanced level, some of these difficulties that people might actually have in their real-world environments. And I know, you know, a question with a lot of these tasks is, are these variables, can they be reliably coded? And the answer over and over has been yes, that we do get good inter-rater reliability when coding many of the errors and actually for the NOT, we have a pretty specified set of inefficiencies and kind of task omission errors that are associated with the different sub-tasks.

Ryan Van Patten 28:34

Thanks for the descriptions of those tests, I, I'd like to ask listeners to picture and be picturing what this looks like to administer this test compared to some of our traditional cognitive tests. And just the degree of structure that we are accustomed to, this relaxed or more flexibility is infused into the test, you know, without compromising test security. If we imagine typical neuropsych tests, a copying, visual constructional test, the number of degrees of freedom, the flexibility that the examinee has to find different strategies or do the test in a different way. They're quite constrained, right? And that's on purpose, where we are keeping things very structured. We're keeping things very standardized and doing it the same way, whereas these naturalistic tasks a qualitative difference between them and a traditional cognitive test is that there's just many more degrees of freedom, many more different ways to approach, different strategies to use to successfully complete the test which resembles the real world. It's not to say that they are better. Our cognitive tests are important for their own purpose, but they're different and interesting, for sure. So the title of your paper, that review paper that I had referenced includes the phrase, "With implications for neuropsychological assessment." That that caught my attention. So I'd like to hear you talk about these naturalistic tasks in clinical neuropsychology. You know, we rarely, if ever administer them as part of our clinical batteries. This is really more in the wheelhouse of occupational therapists, at least traditionally. So what should most neuropsychologists know about these tasks?

Maureen Schmitter-Edgecombe 30:15

Yeah, so overall, these more naturalistic performance-based tests do appear to be useful for assessing cognitive impairment. However, this information can also be obtained with our typical paper and pencil tasks, too. I think these tasks may help to improve our understanding of the types of errors that may impact performance that might be more related to the types of errors that we might see in everyday life just because of the degree at which they, you know, mimic more that ill-structured environment that people might be completing everyday task in. But to date, only a few studies have related performance on these types of naturalistic tests to everyday function. But here also lies atop a challenge, you know, really what type of measure best approximates everyday functioning. So as our outcome measures, themselves, are often only proxy measures of functional status, right? So in this case, if we're trying to look at how well our naturalistic tasks predicts everyday functioning, our predictors are complex performance-based naturalistic tasks, right? Well, what's our outcome measure? It's also a surrogate of actual real world performance. So it's like a questionnaire or maybe if there's another performance-based measure that you know, might be able to equate to what we think is happening in this more complex scenario. So although several studies have found that these naturalistic tasks can provide additional

information over and above traditional cognitive tasks, when predicting everyday functioning, they're still predicting everyday functioning, using surrogates of real world behaviors. So it's really going to be important to demonstrate that these naturalistic tasks provide value to our assessments over and above kind of our traditional measures. But I've been leaning more towards technology, and what can technology can do for the future, rather than the naturalistic task. Although, I think that, you know, one of the things that I've been interested in using technology for is taking that information that we're getting from technology, and then bringing it back into the laboratory, right? To create better clinic-based tests. And so the NOT was like kind of our first attempt at doing something like that. But I think that, you know, there's still a lot more research that needs to be done there.

Ryan Van Patten 33:00

One more question about these naturalistic tasks to close a loop: what is an ideal outcome measure? In a really good study of this, you had referenced this earlier. Like, it doesn't make sense to just use a naturalistic task to predict a real-world outcome, but the real-world outcome is actually a performance-based test in the lab or another naturalistic task. Like, are there gold standard criterion measures where we are following people around and documenting the number of missed medications or the number of car accidents or the number of times somebody left the stove on in their home? That would be, to me, what I would be really interested in knowing as the final outcome that all these surrogates are predicting. Do any of the research studies like, you had mentioned cognitive tests predicting 20 to 25% of variants and real-world outcomes. Are we predicting what people are doing in their real lives? Any studies?

Maureen Schmitter-Edgecombe 34:00

Well, there, there are some measures like pill counts, or you know, technologies that come with things like pill ingestion, or, you know, technologies that come with measuring car accidents with sensors being put in, in people's cars. So I think that technology may be one way that will get us a little bit closer there. I think that there are some outcomes, but even those outcomes, like using mem caps or something to record how often people are using certain medications. A lot of times we may be asking people to do something differently than they typically do, right? If they put their pills in a medication box, and all of a sudden, we're telling them we want to use this pill holder that they have to screw off. We know that some people just stopped using it, right? They may still be taking their medications, but they stopped using that method because it's different than then what they do in their everyday lives. So really finding these ways of actually being able to document what people are doing in their real world environments is important. And I might have time to talk later about some naturalistic observations that we are doing right now in people's homes that are, you know, have sensors and are wearing smartwatches and have, you know, items that they typically use for compensation and for routine. But yeah, that's, I guess that's the million dollar question. Like, how do we get that best measure of real world function, which kind of led me to work with technology.

John Bellone 35:34

Yeah, we definitely want to hear all about the smart homes and everything. Ryan and I talked with Rhoda Au, recently, and in her mind, the neuropsych testing office will be obsolete in the future, because we'll just be collecting data from the person's worlds. From their refrigerator, from their car, all these ambient technologies, and we'll get there, but it's gonna take a while. So in the meantime, we still need our neuropsych measures, and she's still giving paper and pencil tests because there is value there. And there are different questions that those tests answer. So I just, I don't want to lose the bigger picture here.

Maureen Schmitter-Edgecombe 36:14

Yeah, that's what I was gonna say. There are definitely important questions. I mean, we're talking about predicting everyday functioning, but nurse psychologists have to answer many different questions. And some of them, you know, are spoken to better by our standardized clinical test.

Ryan Van Patten 36:28

So let's start really getting into the tech piece. Maureen, I know you've done great work in this area. So we'll be talking about technology to measure real world skills. We're marrying digital tech with ecological validity. But it may not be obvious to everyone why technology and ecological validity should go hand in hand. Some older adults, for example, don't use digital technologies very often, which could reduce their generalizability in the older age cohorts. And then, on the other hand, some cognitive neuroscientists focus heavily on using innovative digital technologies to improve physiological validity instead of ecological validity. For example, sophisticated computerized cognitive test paired with an fMRI scanner to isolate a specific memory circuit. So why do you pair digital tech and ecological validity specifically?

Maureen Schmitter-Edgecombe 37:23

Yeah, well, early in my career, I was struggling with how I could best document the impact of interventions that weren't designed necessarily to improve cognitive ability, but to improve a person's ability to function in their real-world environment. And so we've just discussed all these limitations about, you know, using questionnaires and using performance-based measures. And so I became interested in how technology might be able to help. So could I find a better way to measure real-world outcomes using technologies? Now, of course, that opened an explosion of other questions to be looked at. But I do believe that technologies, unlike our typical current methods, offer opportunities for us to capture more ecologically valid, impartial, and frequent measures of change, as well as help inform us our understanding of things like temporal and contextual factors that may impact everyday behaviors. So I think that there's a real possibility that technology could help us find these better ways are outcome measures that I started with, you know, wanting to have for my intervention research. But also along the way, do things like improve our clinical diagnosis, help with things like early detection, more proactive health care, real time interventions, and more adaptive and personalized interventions, all of which will ultimately then improve the quality of care that we can give to our patients.

John Bellone 39:05

I want to talk more about specific technological approaches to assessment and intervention of cognitive functioning. There are a lot of options here. For example, we have telehealth and computerized cognitive testing. We have virtual reality, VR assessment, ecological momentary assessment, various sensors, like you had mentioned, digital memory notebooks, smart homes, robots, lots, lots of other technologies. Can we just start with sensors because you had, you had alluded to it, and give our listeners an overview of different types of sensors that can be used to monitor patients' activities, accelerometers, passive infrared, wearables, that kind of thing.

Maureen Schmitter-Edgecombe 39:05

Yeah. There are a lot of available sensors that collect different types of data. Sensors, first of all can be passive and located in the environment. So the person doesn't actually have to interact or do anything different with their normal routine. And the infrared sensors that we install on people's ceilings in smart homes, basically what they do is if they're seated or like a person walks into a space, they're going to measure an on event. And then when they leave that space, it's going to measure an off event. So basically what the computer scientists are doing are seeing all these on/off events and trying to use that pattern of behavior to understand where a person is located. And then ultimately, for us, we've been working on activity recognition. We can also put sensors on cabinets or doors, and they will measure when the door opens, they detach, and then when the door closes, they come back together. And so if we put them on a cabinet where medication is stored, that might help us understand something about a person's medication-taking behaviors, or if we put them on the main door to leave the home, we can understand how much a person is is spending time out of the home. We can also capture things like heat, or light. And in terms of other types of sensors, sensors, we've talked about cars already. Sensors can be placed in cars, and they can capture lots of different information about driving behaviors. Now sensors can also be attached to a person, so things like smartwatches, or pendants, or shoe insoles or to equipment that the person might use. So smartphones being a big one, pillboxes, a computer mouse. You mentioned inertial measurement units, which are found in smartphones or accelerometers; they can help us track movement. GPS can tell us information about a person's location. microphones can collect information about noise or voice. Bed sensors and wearable sensors can also capture health information. So things about heart rate or sleep indicators. And really, you know, sensor technologies, it's just continuously advancing. They now have stretchable E tattoos that can detect things like heartbeats. So I mentioned that, you know, some of our sensors are passive, and they just continuously collect data in the real world environment, but other types of sensors do require people to do things, like you know, our wearable sensors like smartwatches. They require batteries, and people have to charge those daily.

Ryan Van Patten 42:38

There's just so much in the space of sensors. So much can be done with them to measure various aspects of thinking and health. Right? For example, you have mentioned accelerometers in our phones, just one of seemingly infinite implications, or instantiations of this that I've seen is to measure somebody's balance. One

way to do that that has people have started doing with phones and accelerometers is to ask somebody to hold their phone up to their chest, and then to do various different types of balance tests like tandem walk, or you know, standing on one leg and keep your balance. And instead of a clinician looking at that person and reading like, "Did they fall down?" we actually have very precise recordings of how much sway they had, did they, you know, did they have good balance, did they maintain it or were they were they off balance? We can do that in a very quantified way with sensors. Just one example of many.

Maureen Schmitter-Edgecombe 43:36

That's a great example.

Ryan Van Patten 43:37

Yeah, yeah. Another great example you had referenced before would be smart homes. So sensors can be used in smart homes, and you've done work in this area. We wanted to move into really getting into smart homes and how we can use this. So just stepping back, generally speaking, smart homes are residential environments that can learn and apply knowledge about the people living in them with the goal of improving the user's experience in some way. So one method to use smart home technology is as a support for functional independence and people with cognitive impairment, obviously very relevant to us. So give us an overview of the current state of the art with respect to smart homes for monitoring and intervening to improve functional cognition.

Maureen Schmitter-Edgecombe 44:25

Okay, so we talked earlier about like the infrared sensors that trigger the on/off events, the cabinet and door sensors. And basically what our group has been doing is using these sensors to create a vocabulary of different activities that people might be doing. So my colleague in computer science, Dr. Diane Cook, her and her team have been working on taking all this data that comes in from the sensors to translate it into a vocabulary that represents everyday activities like cooking, eating, working, exercising, leaving the home. And then what we've been doing is using this information to help us predict things like every day, a person's functional status, or to use it in intervention. So we'll, we'll get to different ways that we can actually use the information that we get from activities. But one of the early questions that we had to ask was getting the ground truth, right, to make sure that these activity recognition algorithms that are being created are actually reliable and valid measures of what a person might be doing in their everyday environment. So we started this work by bringing individuals into our smart home and having them do different scripted activities. And I mentioned some before like cooking, or watering plants, or washing the countertop, or dusting. And then we look to see whether or not we could use the different data being extracted from the sensors. So, you know, the pattern of the sensors, how long certain sensors were on, if this could be used to tell us something about the activity that the individual was engaging in. Later, we then started using smartwatches. And as a person was going about engaging in their everyday activities, we would use ecological momentary assessment, where we would kind of prompt them and say, "What activity are you engaging in right now in your everyday environment?" and then they would tell us what that activity was. And then we could use that information to help build our activity recognition algorithms. And

then to test these algorithms with those people using and living in smart homes, and with wearables, we would have the activity recognition algorithm say, Okay, I think the person was engaging in a cooking behavior. And then we would prompt them and say, "Did you just engage in a cooking behavior within the last 30 minutes?" So those were some of the ways that we have been using to kind of get this ground truth data about the different activities that a person might be engaging in. We also do have people who look at the sensor data, who are given information about the person's every day activity routine, what they typically do, when, where, you know, chairs that they do certain things are located in, and then actually code, what they think is happening in the real world environment. And right now, in a study that we have going on, we are bringing that information to our participants that are in the real world environment. And we were, are asking them, "Does, you know, this pattern of sensor data make sense with this activity that we think you're engaging in?" And we actually have what we call pi vis it's kind of like a program that shows the different sensors that are going off and the patterns that we can also show the participant and talk to them about the time of day that that activity is typically being done. So those are ways that we've been trying to validate our activity recognition algorithms. Now, if you think about like everyday activities, there are a set that we typically will assess, but people do many more activities in their everyday life that are very individual to them. So we've also looked at mechanisms for discovering personal activity, so looking for patterns that occur over and over in a in a household that might be specific to that person. So we've discovered things like, you know, people's scrapbooking hobbies, for example. And another thing that we've had to work on, I say we but it's really my colleague, Diane Cook and computer science, has been working on members, multiple people in the house. So how do you separate these different streams of information? So one of the things that we had hoped to do with our digital memory notebook that we now call EMMA is actually feed information from the smart home about their activities into the digital memory notebook. But one of the problems that we were running into is that we didn't want to feed an activity that someone else was actually doing in the home into someone else's digital memory notebook. So there are a lot of interesting questions that have to be answered here in terms of validating the reliability and the validity of any sort of algorithms that that we develop. And for us these activity recognition algorithms have actually served to assist us with questions like "when's the best time to prompt people?" because we can... we don't want to prompt people during activities that actually involve a lot of cognitive capacity, and we might interrupt them and cause more disruption. And so we started using our activity recognition algorithms to figure out when people were transitioning between activities, and then prompt during those transitions between activities. So there's a number of different ways that we have been applying these activity recognition algorithms. But ultimately, what we want to do is, is take this information then to help us understand about a person's everyday functioning, about changes that might be occurring and in healthcare status. So that we can be more proactive and preventative with our interventions.

John Bellone 50:56

It is very cool. There are so many parameters that you could look at. You had mentioned, like if somebody cooks something, then 30 minutes later, you could ask them what they had done and what they cooked to test their memory. And I've also seen other parameters like distance traveled within the home and transition between different rooms, time of day spent in the house versus outside. So just seemingly endless parameters and application for this.

Maureen Schmitter-Edgecombe 51:24

Yeah, absolutely. I think that some of those parameters might allow us to detect changes that maybe a person isn't even aware of. So maybe they're not aware that they're changing the way they're walking around their home, or how long it's taking them to do a particular activity. But we're able to pick up some of those changes, you know, with the sensor monitoring, and then, you know, that allows again, for that idea of more proactive and preventative interventions.

Ryan Van Patten 51:53

Great segue, you've alluded to and referenced interventions a few times, so I'd like to focus in on that for a second. Smart Homes can be used for intervention for improving functional status, as well as for assessment like testing and measuring if there's a problem. So for example, you've done work with smart homes that are designed to mimic caregivers by auto-prompting the resident if an activity of daily living is not performed, one of many things that a caregiver does is provide reminders like brush your teeth, don't forget to take your medications, don't forget to take the trash out. So we might be able to automatize that. And you've also integrated a digital memory notebook that you referenced a minute ago. We'll talk more about that in a few minutes. So generally speaking, what do we know about smart homes as cognitive or functional interventions?

Maureen Schmitter-Edgecombe 52:45

Yeah, our idea was to try to create prompting that would mimic what a caregiver would do by using clinician intervention as ground truth, or when a prompt would be delivered. So the way we started out this work, was bringing people across the continuum from healthy older adults through dementia into our smart home and having them engage in different activities of daily living. We had, before that, broken each of these different activities down into the different activity steps. And then we pre-recorded prompts to give the individuals and we base this on the way that caregivers would typically prompt so usually they'll start with kind of an indirect cue to kind of get the person back on track and then become more directive. And then we had a multimodal cue that was, you know, a verbal directive, and also showed the individual what to do. And so the examiner was upstairs in the smart home as the person was engaging in activities. And when they made an error, and the examiner felt a prompt needed to be delivered, they would deliver the prompt. So the idea would be then that our algorithms could then learn when a clinician would typically deliver a prompt. And so that was our ground truth. So for that study, we did find that indirect levels of cues are actually quite effective in getting people with mild cognitive impairment back on track. In some of our other studies, we also found that people who had more cognitive difficulties actually preferred having more direction with the cues that were given. The other thing that we found by watching behavioral observations of individuals with dementia is that continually giving prompts when a person is not getting any better, is not always the best thing to do, right? We weren't giving any sort of positive reinforcement or any sort of redirection, and so that has to be part of the makeup of any sort of automated prompting To there has to be, you know, some sort of positive reinforcement and caregivers do that, right. It's not just like negative, negative. The other thing that that we were asking too is what types of errors

could our smart home realistically pick up, right? So we have sensors that are in the environment. What are they going to be able to detect? So we had undergraduates come into the Smart Apartment on campus and we described to them an activity that they, we wanted to do. And you know, the types of difficulties that someone with dementia might have. We didn't tell them what sort of error to make, we just gave them like basic characteristics of the types of difficulties a person may have. And then we just asked them to make errors. And we quickly found out that there were lots of errors such as you know, putting too much milk and oatmeal, that there was just no way that we are going to be able to detect with our sensors, but you know, they weren't going to make things very pleasant for a person in their everyday life. Their oatmeal wasn't going to be that enjoyable. So we pivoted a little bit to looking at prompting for the initiation of activities such as prompting to use a digital memory notebook or to exercise. And one of the first challenges I already alluded to there is when should we initiate these prompts, you know, we don't want to cause more problems for people in their everyday lives by interrupting them. And these can be different than time-based prompts, right, a time-based prompt might be set when a person is taking a nap or, you know, really engaged in another activity. And so here in again comes our activity recognition, if we can recognize when people are engaged in activities, and then detect when they're transitioning between activities, maybe we can get people to respond to our prompts at a higher level. And actually, in both real-world environments. And in our Smart Apartment experiments, we were able to show that when we use the context-based activity transition in comparison to just random prompting, that people responded to more prompts and actually rated the system with a higher degree of satisfaction. And regarding our work with a digital aid, if you want to help a memory-impaired person automatize or acquire a habit of regularly using some sort of digital memory aid, then a time based prompt again delivered when a person you know is napping or involved in another activity might not be effective. So in some of our work, where we partnered a smartphone that could recognize the activities the person was engaging in and transitions between those activities, we delivered prompts to use a digital memory notebook. Now some other cool things about technology is that if a person is actually engaging in the behavior, so if they are looking at the digital memory notebook, we our goal was to have them do this six to eight times per day. So we made a rule that if they hadn't engaged with the digital memory notebook for 90 minutes, we would prompt them at the next transition between an activity. And so if the person was, you know, engaging in the behavior that we were trying to create that habit, then they didn't need to get prompted. So people can use their, you know, their own cognitive abilities. And then at the same time, we know whether our prompt is actually effective, whether they go and use the digital memory notebook. And so if they don't, then we can re-prompt them. So there's a lot of exciting things that technology can actually do to help support some of our interventions.

Ryan Van Patten 58:57

Yeah, you're referencing this prompting, creating habitual behavior, which is a core aspect of compensatory cognitive training with people who are losing declarative memory, we are capitalizing on implicit memory and habit learning to create this structure for people so that they can improve their functional independence. I wanted to just real quick ask a clarifying question for our listeners who aren't familiar with what this looks like? What would auto-prompting in a smart home look like? Do you have a robotic voice coming out of the walls telling, telling the person what they have to do? Or is there a TV screen that flashes with instructions? How is it effective to auto-prompt?

Maureen Schmitter-Edgecombe 59:41

Yeah, that is a good question, and early on there are lots of questions to answer there about how to best do this. And one of the questions was, what sort of voice should we use? Right? So we had to go to older adults and ask that question. Like, how would you want this and most of them just said, you know, some sort of nice calming voice, most of them were preferring a female voice, even though the tone for a male voice might be better for for hearing difficulties, but we ended up going with a female voice. And in our smart home, yes, it did just come out of some speakers. And so that's how it worked. We have done some things with robots where the prompt comes, you know from the robot who approaches them. And when it was multimodal, the prompt actually cued them to move to a computer screen. And then they would get the verbal prompt and also the activity. For the digital memory notebook, the prompt the digital memory notebook, we came up with a really nice ringtone, that... kind of like a fun ringtone. And so they would hear this ringtone, which would then tell them to go and use their digital memory notebook or ask them if they'd like to use their digital memory notebook. But those are... that even brings up another host of questions. I was actually just asking another researcher about, you know, what, what are the best ways to really inform people with these prompts, right? We've experimented with a few things and I've told you some of the things we've learned along the way. But if we are going to have these auto-prompts they're, they're going to have to adjust to different people and that in and of itself is going to be a whole other computer science question to figure out.

John Bellone 1:01:37

Yeah, the 1000s of details, the little minutiae that you don't think of. There is an interesting application to all of this that you've worked on called Clinician in the Loop, and how a patient's clinician might be able to receive critical information from the smart home sensors to improve real time tracking and clinical decision making. I'm curious about that idea in general, and how just to bring it back to neuropsychology, how neuropsychologists might be in the loop in the future?

Maureen Schmitter-Edgecombe 1:02:08

Yeah, well, we called it Clinician in the Loop, actually, for two reasons. So one reason was that we had a clinician actually looking at the sensor data to provide some clinically-based kind of decisions about that sensor data that might help the algorithms. And then in terms of the clinician being involved in the overall tracking intervention. So even though it's possible that this could be like an automated loop, we don't really envision it that way. We envision it as something that you know, is always going to need a clinician to be monitoring and making some decisions. But this data that's coming from the smart home, you know, can augment that information. So, in terms of assessment, I think one of the ways that it neuropsychologists can use this sort of data is to help monitor trends, because there's lots of variability in behavior, right? And a lot of times we see people in the clinic at you know, time one, maybe we catch them on a bad day. And so and they're anxious, first time they've been in the clinic, we get behavior that maybe is lower than what they could typically perform at. So they come in a year later, and they look the same. But you know, we're being told that in their everyday environment, they're having a lot more difficulties, they're having more memory functions, they're, you know, they're having

trouble cooking or leaving the burner on. But our data is not showing any sort of change. But if we had this continuous monitoring in the home, and we could see that variability, or maybe that downward overall trend in behavior, that would really help us with some of our clinical decision making. And those sorts of instances, it could also lead to more proactive interventions, again, if we're monitoring this, and we see some of those downward declines. In terms of intervention, you know, if a neuropsychologist has assigned some sort of particular intervention that could be captured by the sensor data, for us, you know, use of our digital memory notebook, but could be increased physical activity to improve brain health. The data from the smart home could provide the clinician with information about uptake or adherence to the intervention. So if a person seems to be having barriers, you know, a couple of days into the intervention, maybe you don't have to wait that week or two weeks or month until you see the person next, to be able to do some sort of motivational intervention or see what those barriers are, and thereby improve the efficacy of your intervention.

John Bellone 1:04:48

Yeah, this is what I was referencing earlier regarding the ambient technologies and our conversation with Rhoda Au, she was very much moving in this direction. In the future, future, right? Our testing won't be obsolete for quite a while. But I think the first thing in people's mind that pops into people's minds, when we talk about all this data being collected for somebody is privacy. And so I just wanted to ask you about how you envision the data being protected? And how can clinicians use this information without it getting in the hands of people who have, who don't have the patient's interest at heart?

Maureen Schmitter-Edgecombe 1:05:21

Yeah, there's definitely a lot of work surrounding privacy right now. And we really have to lock down a lot of our technologies. And there is like, a lot of information that, you know, if you're using smartwatches, or tablets, and you're allowing people to use the speech to text, the speech to text is something that Apple gets to that data, or if you have the GPS on, they call it for security reasons, they track IP addresses. So there, there's general information that some of these third parties do have access to, but they don't have, you know, the data linked at the person level. Although, you know, one of the questions is, you know, can they do that if the if they really, you know, wanted that information? And so, there are things that you do need to make your participants aware of, in terms of, you know, if, if you're using different aspects of technology in your research. I think, you know, people are aware of the issues surrounding security. Definitely, we have had participants say like things with our EMMA, our electronic memory management aid, which is our digital memory notebook, you know, we have asked, Would you, like, you know, caregivers to have access to that information or health care providers, and, you know, definitely, they're like, "Well, this part of the information, you know, would be fine, but like my journaling information, or like, you know, things that are a little bit more personal, I wouldn't want them to have access to." So you know, even within certain sorts of technologies, there may be parts that people may want to keep more personalized, and other parts that they would feel comfortable other people having access to. And then we run into situations to with smart homes, when we're recruiting people for studies where maybe, you know, a family member wants someone to be involved in the study, because they're, you know, going to have these technologies that are going to monitor people, but the person with you know, mild cognitive impairment

themselves is not interested in the technology. And of course, us as researchers, right? Well, we're not going to enter that person into the study, because they're not going to give their consent. But this may differ, you know, when technologies become more widely available. So I think that these are going to be important questions that we are going to have to tackle.

John Bellone 1:07:52

Some of these technologies might also just seem daunting to users, particularly some older adults, and or people with cognitive impairment. Can you just talk to us about the importance of user friendly design when applying digital technologies to issues of functional capacity?

Maureen Schmitter-Edgecombe 1:08:18

Yeah, that that is great. I am a very big proponent of working with the users. And I think the field has seen that that is so important. The engineers always used to tell me, "Yeah, we were always of the opinion, if you build it, they will use it, right?" And then after working with us and starting to apply things to real people, they began to understand the importance of really working with the users. And I think that, you know, this has been seen in groups over and over and over again. So most people now when they're developing new technology, it's something that's done iteratively with the group of users that that you're working with. And in developing our digital aid, which I mentioned before, that we call EMMA for electronic memory management aid, we took that through five iterations. And we started with an Android interface because you know, we thought it was cheaper, and would be more easy for people to get a hold of, but it quickly became clear that older adults really preferred the iOS interface. And then we started with all sorts of principles of you know, design for older adults, big font, good contrast, big buttons. We used, you know, our empirically tested work with paper and pencil memory notebooks, but we continue to iterate and find ways to improve on the design to make it easy for older adults. One illustration of a design principle was setting the time, so when people have to decide, you know, the time of an activity, you know? Most of the apps have those dial pickers that you have to turn. I hate those but our older adults really did not like those. And it took us quite a while to come up with a very simple design where they just press buttons and the time was set. So making sure that, you know, your design is going to be easy to use, for that population and it's going to be something that is important to them, and they want to use. So there's lots of models out there, looking at older adults' acceptance of technology, looking at different factors that affect their acceptance of technologies. And these, you know, range from things like the usefulness of the technology, to the support available, to the cost, to the self-efficacy. And these things are all important to be thinking about when you're developing these types of technologies. I think there's such value in these technologies because they can actually make some of our compensatory strategies that we've demonstrated empirical efficacy for better. So we know a paper and pencil memory notebook works for individuals with TBI works for individuals with stroke and improving their everyday functioning and helping them to remember to do things in the future. Our group and others have also demonstrated that it's helpful for people with amnestic mild cognitive impairment. And in my work training a paper and pencil memory notebook, one of the first things that you have to do is make sure that they're on the current date, right? So if, you know, today's Tuesday, whatever, the person needs to look to make sure that they are on that correct date. And that typically involves having them look at the TV or a clock or

some other method. And then, you know, moving some sort of string or something to that date. But with an electronic aid, like, EMMA, you just open and you're on the Today page, so you know you're on the current day. And if you end up putting something in your calendar for a future day, the button that says today on it turns to "Go to Today" and then you just press it and it takes you right back to the Today page. So now you've already simplified something that could actually take quite a long time, right, to train someone to be able to remember to do and in fact, that used to be one of the first things that was on their list: first, check the date and make sure you're on the current date. And then you've got that reminder alarms that can be sent sets, we already talked about the prompting, you know, usually we would have a watch that would go off every hour reminding them to you know, use the paper and pencil memory notebook. And now not only can we prompt to use the aid itself, but we can prompt them before different activities that you know they've scheduled for that day that they want to engage in.

Ryan Van Patten 1:13:02

Yeah, user centered design is so critical in this space. It's very important for us. In digital neuropsychology, whenever we're thinking about these technologies to improve what we do, assessment and intervention, to consider the user. There's a lot of great resources that people are interested in reading more about this. I've really enjoyed the book, "The Design of Everyday Things," by Don Norman, there are many other papers and books. This is a very interdisciplinary world, right? There's a lot of psychology, ergonomics, computer science, engineering that goes into this sort of thing. It's fascinating. Maureen, you've mentioned the digital memory notebook and EMMA multiple times, I wonder if you could just give us a brief description of what the current iteration of the digital memory notebook looks like. I've read about the different features, the, the home, calendar, profile, and notes components. So just briefly describe it for us.

Maureen Schmitter-Edgecombe 1:13:56

Yes. So EMMA actually has a new component to it, which is a health tracking feature, which we're really excited about because we think that's going to give us more information for tracking health over time, as well as integrating a lot of important brain health factors. And it also has a cognitive n-back test that we've used in some of our ecological momentary assessment data collection where we can actually have a person do a cognitive task within the real world environment that may be impacted by things like, you know, internal or external distractors, maybe stress, physical fatigue. So, in terms of how EMMA currently looks: it has a homepage that has the the scheduler and the to do list. It then has a calendar which has a the bigger overview, and then it has a health button now and the health allows for recording of medical information that may be important when you go to the doctors have. You know, flu information. And this is all information that older adults were interested in having in this digital space. And some older adults have that have used EMMA in the past, have said they actually take it to the doctors and have the doctors put information into it for them. But then the other aspect of the health allows them to track things. And these were all designed with older adults in terms of what are some of the most important things you want to track, things like weight and blood pressure, whether they're taking their medications, and then it has goals. So they can have set exercise goals, they can set wellbeing goals, they can set goals for cognitive activities, they can also track things like pain or fatigue levels.

And then we've got that cognitive and back test. And it's designed so it's very easy to use. So if a person is setting up an activity, and they say they're going to walk with their friend today. And they want to designate that as a health activity, when they're setting up the activity, there's a button that says health event, and they just push Yes. And then when they check off the activity that they completed it in their schedule, it comes up and it asks them how many minutes of exercise and then they just put in the amount of minutes. And then if they want to view their graph to see how they're doing for that week, they can view their graph, they can look at it over longer periods of time. So again, you know, working with that user-centered focus with the older adults to design something that would be really easy to use. And in fact, when we first brought the health idea to some people who had been using the earlier iteration, they were really clear that it had to be really simple to use, because it was you know, the system was working for them now, and they didn't want something that would be too complex. So I hope we've achieved that. We are using it right now in a study with Sarah Farias, not the complete health tracking, but the exercise and the cognitive activities and the well being and an intervention that is combining compensation with brain health training, and then using EMMA as a tool to help support that integration. And those older adults are using it well. But we are about to embark on a clinical trial that will use the full new configuration of health factors, and so we'll, we'll see how well we did.

Ryan Van Patten 1:17:35

EMMA is an app, right? That people can use on a tablet or a smartphone. Is that how they are using it in their lives?

Maureen Schmitter-Edgecombe 1:17:42

Yeah, and I think this kind of fits in with a question that you might be interested in, in terms of or that is important, I guess, when we're designing technologies, and that is, you know, making sure that we're not increasing that digital divide, right? And when we first started creating EMMA, we created it for a tablet. And so the person needs to take the tablet with them. Well, people started saying, "Well, I want to be able to access EMMA from my phone and from my computer, because I want to print things off, or I don't want to take EMMA with me, but I have my phone with me." So then EMMA now is a web-based application where it can still just be on the platform of the tablet, but now people can get to it from the phone and from their computer. But that now involves AWS, Amazon Web Services, which is costly. So you know, the more things that you add, you know, the the more cost net that start to come in to some of these technologies. And we have worked really hard with our smart home to kind of keep things, you know, things that you can get off the shelf, to use technologies like smartwatches, or tablets that are already out there when designing some of these apps. But I think it's something that we have to consciously be aware of as we move forward. Because even thinking back now, I think, well, you know, the older adults that we started with were highly educated, Caucasian, probably had a, you know, a pretty decent amount of spare money. Was that the reason that we ended up going iOS rather than, than Android to start with? So I think all these things are important because now, you know, the hurdle that we're getting from people is, well, I want it to be able to integrate with all of my other calendar devices. And that makes sense, right? You don't want to be able you don't have to, like enter things into multiple

calendars. By now you got to figure out how to make EMMA work with like Outlook, right or, or Google. So you know, there are lots of challenges that that continue to present in this space as we work to develop EMMA out.

John Bellone 1:20:01

I'm glad you mentioned about cost. That was gonna be my next question because what we're talking about is pretty involved. All these infrared sensors and tablets, other devices. And we want to be mindful of health disparities based on income and socioeconomic status, and keep these accessible to as many people as possible. So I'm glad you're thinking about, about that. I know there's not really an easy answer.

Maureen Schmitter-Edgecombe 1:20:25

I can tell you one thing that we started working with, and I've been thinking about, maybe this might help are items sensors. And item sensors, the ones we're using right now, we can actually put in people's homes for a week or more, before we had item sensors that would have to be charged every 48 hours. So those weren't really usable. But what we've been doing is trying to identify people's routine behaviors, and target the items on those routine aspects. So things like you know, if they get coffee every morning tagging the coffee maker, tagging their medication, tagging a hairdryer, so that we could get an idea of kind of like what their activity might be throughout the day. So this might be, you know, a like a, you know, in the future like sending people home with a smartwatch and maybe some items for them to tag and, you know, getting information back about that in a way that might be different than having people put a whole smart home in, although our smart home in a box is is, you know, we've been trying to keep that very affordable. And we've demonstrated that people can actually put the system in themselves. But in our research, we typically come in and put the, the smart home in. So there I mean, I think there's hopefully going to be ways that we can, you know, make this work in the future. But I think the important thing is that we are mindful of it. And we continue to think about it. And, you know, don't let this become something that can help some people but not other people.

Ryan Van Patten 1:22:03

Yeah, so we've touched on privacy, accessibility, and user-centered design, which are three really important issues. There are many other important issues in this space. So I'd like to step back for a minute, given what we've talked about today, ecological validity and digital technology, you might have a techno-optimist wondering, since we have all these real world tasks that closely mimic what our patients are doing in their real lives. Why are we giving clinic-based cognitive tests at all? Why don't neuropsychologists just ask patients about you know which functional abilities are most important to you? Is it driving, cooking shopping something else, and then select a virtual reality-based or other digital real-world test that measures those abilities very directly, instead of using our abstract cognitive tests. So what would you say to that person?

Maureen Schmitter-Edgecombe 1:22:55

Well, I guess I would say that the question that you're answering is going to be, you know, the important thing that drives how you're going to form your, your assessment work that you're doing. So I think I'm booting this question.

John Bellone 1:23:13

It's... we had talked about it a little bit earlier about, you know, the difference between physiological validity we're trying to get as close to the actual systems level, the neurological system circuits versus ecological real life functioning. And these are different questions, like you mentioned, a referral source might be interested more in the physiological side versus the ecological. So I think, like you said, it depends on the question being asked, to some degree.

Ryan Van Patten 1:23:40

There's also a lot of power to cognitive profiles and characterizing cognitive impairment, which we do really well with our neuropsych tests that have decades of validity data. And although no specific neuropsych test translates perfectly to real world functioning, if we give a neuropsych battery, and we know where that person is functioning in different areas of cognition, that can generalize to a lot of IADLs, you know, we're not just measuring in a one to one way, can they drive in a simulator? Or can they make a peanut butter and jelly sandwich, we're characterizing their cognitive functioning, and then that gives us information about work and home and medications and all the different IADLs. It's not, it's not perfect, you had mentioned, Maureen, I wanna really highlight and repeat that 20 to 25% variance is accounted for.

Maureen Schmitter-Edgecombe 1:24:33

Exactly.

Ryan Van Patten 1:24:33

There's a lot, yeah, there's a lot left there, but 20 to 25% in psychology, if we're predicting, and if we can explain 25% of the variance in an outcome, that's not nothing.

John Bellone 1:24:45

Especially when we're talking about human behavior and how difficult to measure those. Yeah,

Ryan Van Patten 1:24:50

Yeah.

Maureen Schmitter-Edgecombe 1:24:51

But we also have to remember that when we're talking about that 20 to 25%. We're talking about cognition predicting proxy measures of everyday functioning, right? So it's our performance-based measures, or it's our questionnaire measures. I do agree that, you know, cognition allows us to have like this, this broader view. But it's also important to remember like the environment can play a significant support for people. So think about prospective memory, like we try to test it in the lab, but we don't allow them to use compensatory strategies or anything that they might use in their everyday environments, such as setting an alarm. So we might come, like, our conclusion may be very different about how they're actually able to remember things in their everyday environment if they've got really good compensatory strategies in place. Or, you know, maybe in their everyday environment, it's, you know, personality or health factors that are actually bigger players and you know, their, their everyday performance, then, then cognition. I think, one of the neat things about ecological momentary assessment that we talked about earlier, is this ability to get information about how a person is functioning in the real world environment. So we can ask them at that moment in time, "How fatigued are you? How, you know, mentally sharp do you feel?" And then one of the things that we've been doing is combining this with a brief n-back cognitive test and other, other researchers have started to use brief cognitive tests in the real world environment, to better understand kind of that dynamic association between internal and external contextual factors, and a person's cognitive performance in the real world at that moment in time, and to look at those fluctuations. And also, there's all sorts of like, newer statistical techniques that are available that not only can we look at that repeated data at the group level, but we can also look at the individual level, and if we can start to understand different actors that impact people's cognition in the everyday environment, then, and you know, if we're impacting cognition, and we're probably impacting their everyday performances, right? If we can figure out ways to intervene, that are specific for that person, that again, may be a way of improving some of our interventions and making them more personalized.

Ryan Van Patten 1:27:24

Maureen, I'd love to get your, your take, your advice on this. Imagine a clinical neuropsychologist, who does all clinical work, comes to you and asks, you know, I use typical neuro psych cognitive tests and self report questionnaires. I've read some of your research, should I be using more of the naturalistic tasks like the night out task? Would that make me better at my clinical job? Or should I be using the... some performance-based lab tests or virtual reality tests or something else? Based on your knowledge of the psychometric data and clinical utility, what advice would you give someone?

Maureen Schmitter-Edgecombe 1:28:05

Yeah, I don't think that we're there yet. I mean, one of the things that we still need to do with a lot of our naturalistic performance-based tests and technologies is demonstrate that they are reliable and valid, and that they are providing us with information over and above what our traditional tests do. I do think that it's important to be aware of these. And I think that neuropsychologists are like, they have the knowledge to develop these out, right, to make our methods better. And as an example, with the night out tasks, we actually

started using it in our clinic with, with our ADHD assessments. And we have seen patterns that are very different from what we see with our older adults who have mild cognitive impairment. But there we see people who are telling us, "Yes! This is where I'm having problems." Their... all their data, you know, their clinical data with our neuropsychological tests looks fine. Their self-report of what's happening in their everyday lives is consistent with ADHD. And then we give them this task, and we see they are starting and stopping and interrupting and, you know, just not as efficiently completing these tasks as as a typical, younger adult does. So I think that there are some situations where some of these tests can provide information over and above what you might get from traditional cognitive tasks. And there are certainly more performance-based tests out there that are starting to get more data behind them in terms of reliability and validity. And I think that in doing any sort of assessment, it is important to look both at your cognitive data and to, especially if you're the questions relating to everyday functioning, to include some sort of performance-based test. And in fact, Tanya Jia Veneti and I just wrote a chapter for the Sage Handbook of clinical neuropsychology, that's going to be coming out. And it basically details like for a clinician, characteristics of questionnaires, of performance-based test, and of technology that researchers may want to think about in terms of choosing the type of tasks that might be useful for them in their clinic. So I would refer the reader to that. The other point I want to make is not only just looking at the cognitive data and the performance-based data, whatever sort of performance-based task you might choose, but also keeping in mind that everyday functioning is multifactorial in nature, right? So we do need to be thinking about what resources they have available in the home, you know, what other sorts of factors health conditions might be affecting their everyday functioning, that may not make that translation between capacity that we see in the clinic to implementation in the real world environment?

John Bellone 1:31:16

Clearly, there... this is an emerging area and will be important for both assessment and intervention. And no doubt that technology will only improve what we do in this area. Thank you so much for all this information. This is really a fascinating topic. We do have two bonus questions for you before we let you go.

Maureen Schmitter-Edgecombe 1:31:38

Okay, can I just say one other thing?

John Bellone 1:31:40

Sure, of course!

Maureen Schmitter-Edgecombe 1:31:42

Okay, I just want to mention in terms of technology, and what it can do for assessment, I think we talked before about the fact that it could capture that variability in performance and kind of those trends over time, that I think could be really important in diagnosis, it can also provide, you know, insights on that interaction between kind of person, task, and environment. And I hope, like later on, we could use machine learning to help identify

both like cognitive and non-cognitive factors that might be impacting everyday functioning. And I think if we're able to kind of use the best of both worlds, now it could be eventually technology takes over, but I think that there are important things about the way we do our assessments right now that can be combined with what we're understanding from technologies to improve our work in the naturalistic environment and our ability to predict, you know, how people are performing in their everyday environments.

John Bellone 1:32:49

Yeah, I completely agree. For a long time, I can envision there being both the neuropsych eval in the office. And then as an adjunct, we also collect data to get at that variability that you mentioned, day to day within day variability. Also, this is very consistent with the Boston process approach, we're getting not just one outcome measure, but a lot of data that can tell us about how someone approaches a task and the errors they make. So there's just a richness of data that we just can't get from paper and pencil tests in the office. So I think this is going to, they're going to work together to help us both with the assessment and the intervention process. So I'm glad you added that. So the first, first bonus question and these, these can be relevant to ecological validity or technology, but they don't have to be. If you can improve one thing about the field of neuropsychology, what would it be?

Maureen Schmitter-Edgecombe 1:33:49

I think, I mean, it is relevant to this is what I study and this is what I'm excited about.

John Bellone 1:33:54

Yeah, I figured.

Maureen Schmitter-Edgecombe 1:33:54

And I think our ability to predict real world behaviors is really important. I mean, neuropsychologists are being asked those questions, and we need to make sure that if we're answering them that the methods we're using for answering them are reliable and valid methods. And I think that technology and the integration of technology in our field is going to be very important. I think we need to embrace it. I think we need to make sure that our future generations of neuropsychologists are trained, you know, with technology to meet these challenges. And I hope to see us playing an important role in the advancement of these technologies, because I think they have a lot to offer our field.

Ryan Van Patten 1:34:45

You had mentioned earlier in this conversation about how face validity isn't enough, and I couldn't agree more. You know, we can have a test that is called a test of a real world ability like a test of driving. And yet this test of driving is done on paper and pencil in a two dimensional format. And it's not dynamic; cars aren't coming at you.

So, maybe it predicts driving but maybe not. So the verticality, the statistical prediction, the criterion, or predictive validity is so important. We need to get the psychometrics, right, not just choose tests that look like they might be measuring what we care about.

Maureen Schmitter-Edgecombe 1:35:25

And I think, let me just add to that, that that's one of the things that I worry about. If we leave this up to other professions that don't understand as much the importance of reliability and validity and developing these measures. I mean, it is hard, because technology's changed so fast too, right? And so we've got to figure out how to do this. But we have to do it the right way. We can't let other people just say, "Oh, here's a good measure of, you know, functional performance," and we haven't made sure that it really is a reliable and valid, kind of, biomarker of functional performance. So I think we have to, we have to be there, we have to be part of this work.

John Bellone 1:36:09

Yeah, we also bring to the table the standardization piece and the understanding the difference between the criterion-based outcome versus like a norm-referenced outcome and whether, you know, if it's a 90-year-old, can they, are they driving on par with other 90-year-olds, or are there certain abilities that they have to have, regardless of age? And so I think we also bring that to the table in a way that other professionals maybe aren't quite as focused on so...

Maureen Schmitter-Edgecombe 1:36:38

I agree.

Ryan Van Patten 1:36:38

Hence the multidisciplinary aspects of this. So Maureen, what is one bit of advice you wish someone told you when you were training, or maybe someone did tell you that really made a difference? So here, we're looking for an actionable step that trainees could take to improve their performance.

Maureen Schmitter-Edgecombe 1:36:55

Yeah, I would suggest that they seek out and embrace opportunities to work with and gain experience from individuals outside their own discipline. This allows you to see situations from multiple different viewpoints, it also opens up opportunities for pushing the field further, I think, you know, most of my most rewarding, although I've had lots of rewarding collaborations with other neuropsychologists, but I think I've found the science to be really exciting when crossing between disciplines. It's not always easy, right? Because there's like, even technical words that that you'll get hung up on that might mean different things in different disciplines. But what you can produce, the work that you can do, I mean, the things that we've been able to do that I just

imagine, but you know, the engineers and computer scientists said, "Oh, yeah, we can do that." I'm like, "What? You can do that?" It's, you know, it's just really exciting. So I would say, you know, open yourself up, you know, get to know people in different disciplines and how they do their work.

Ryan Van Patten 1:38:03

Wonderful. Maureen, thank you so much for your time. And having this conversation. It's a great topic, really two great topics, ecological validity and digital technology in neuropsychology and we put them together for this conversation. I love it.

Maureen Schmitter-Edgecombe 1:38:16

Thank you for having me.

John Bellone 1:38:17

You're welcome. Well, you can tell how excited Ryan and I both are about this topic, too, and how much we enjoy covering it.

Maureen Schmitter-Edgecombe 1:38:24

Thank you too, for like taking all the time that you did to like, really think about the information and read through the materials, like that was very impressive. And I guess it's kind of like teaching a class. This is one way that you guys can like really keep up on all this information.

Ryan Van Patten 1:38:40

Yeah, totally. Yeah. Thank you for the book, by the way, for sending us a copy. You're editor of the book. We've now interviewed all three editors of the ecological validity. We interviewed Igor about marijuana use, Tom about marijuana driving, and now, now you so...

Maureen Schmitter-Edgecombe 1:38:58

Oh, good, good, well, wonderful.

Ryan Van Patten 1:39:00

Yeah. Well, thanks so much for your time, Maureen. It was a great chat.

Maureen Schmitter-Edgecombe 1:39:03

Okay, all right. See you guys later. Bye.

Exit Music 1:39:05

Ryan Van Patten 1:39:10

Well, that does it for our discussion with Maureen. As mentioned in the intro, the INS and other promotes nor recommends any commercial products or services discussed in this episode. Be on the lookout for upcoming episodes on neuropsychiatric symptoms in neurodegenerative diseases, Parkinson's disease, cognition and addiction, neuropsychology in infants and toddlers, CTE, and other topics. As always, thanks so much for listening, and join us next time as we continue to navigate the brain and behavior.

John Bellone 1:39:45

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Ryan Van Patten 1:40:21

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