45| Neuropsychology on the Go: Ecological Momentary Assessment and Mobile Cognitive Testing – With Dr. Raeanne Moore

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NEUROPSYCHOLOGY

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Speakers: Raeanne Moore, Ryan Van Patten, John Bellone

🔊 **Intro Music** 00:00

Ryan Van Patten 00:17
Welcome, everyone, to Navigating Neuropsychology: A voyage into the depths of the brain and behavior. I'm Ryan Van Patten…

John Bellone 00:24

…and I'm John Bellone. Today we bring you our conversation with Dr. Raeanne Moore. She's an Associate Professor of Psychiatry at the University of California, San Diego. Her research is focused on innovative mobile technologies to improve the assessment of cognitive and emotional functioning in a variety of clinical populations, which is pretty relevant to our current scenario with COVID-19.

Ryan Van Patten 00:48

Without a doubt. We talked to Raeanne about a variety of technologies and platforms relevant to these clinical populations. There's a lot of content packed into this episode, including ecological momentary assessment, or EMA, mobile cognitive testing, or MCT, natural language processing, or NLP, GPS tracking, the Internet of Things, and among others. So there's a lot to take in here. We hope you enjoy it as much as we did. And now we give you our conversation with Raeanne.

Transition Music 01:21

Ryan Van Patten 01:31

We are here today with Raeanne. Welcome to NavNeuro. We're thrilled to have you.

Raeanne Moore 01:35

Thank you for having me.

Ryan Van Patten 01:37

Today we'll be talking about your work in innovative electronic data collection methods. This is a very cutting edge topic, and even more so right now with the current pandemic largely preventing in-person data collection. Before we get into our questions, you mentioned to us offline that you have one conflict of interest to mention at the forefront. Would you like to do that?

Raeanne Moore 02:00

Sure. Yeah. I'm a co-founder and serve on the Board of KeyWise AI. I am also a consultant for NeuroUX. So probably technically two conflicts of interests.

Ryan Van Patten 02:10

Okay. So to start, we can differentiate between active and passive data collection methods. Will you delineate those for us?

Raeanne Moore 02:19

Yeah, absolutely. When we collect digital health data using mobile devices, we will usually either collect active data or passive data, or sometimes a combination of the two. What we mean when we say active data is just really asking for data from the user. So we're asking the user to input data in some kind of way. This is usually done via smartphone, but there are some kinds of wrist worn wearables, like Apple watches and things where you can input data directly into that device as well.The kinds of questions we're asking about when we're trying to gather active data are, we'll administer surveys where participants respond, we'll administer mobile cognitive tests without to actually perform the task. Symptom tracking apps are another example of active data collection. Passive data collection, on the other hand, is data that's collected without asking the user for it. It's data that's collected, usually continuously, and should be unobtrusively collected in the background. Types of passive data we collect are things like GPS data, people's browsing histories on their smartphone. You can look at how many times people just pick up their phone during the day and how that may relate to social activity. We can get social media usage - so how many times people are logging into social media apps, their scrolling activity, their tapping activity. It's not actually collecting any of the data that people are doing with the app on these different devices, but it's just the data that you get in the background basically.

Ryan Van Patten 03:53

Our phones are such a central hub for our lives these days that it makes sense to use that, to leverage it, to collect both types of data you mentioned. Even the passive data, I imagine, can be very illuminating in terms of different aspects of a person's functioning.

John Bellone 04:08

What is ecological momentary assessment, or EMA? My understanding is that this is an active form of data collection. How is it useful for neuropsychiatric populations?

Raeanne Moore 04:20

So, EMA - it's also sometimes known as intensive longitudinal sampling or experience sampling methods. This is an active data collection technique. It was

defined and originally made popular by Saul Schiffman in 2008. He defined it as a brief frequent repeated surveys that are delivered on a mobile device. These are usually delivered on a smartphone in today's day and age. Previously, they were delivered on PDAs or, even back in the day, people could administer them via paper or pencil. That's how many people fill them out in their daily life. Typically, we keep EMA surveys around two to three minutes. They're just short brief surveys that people can do fairly quickly on our smartphones. The goal of this type of sampling technique is to capture behaviors and experiences in real time while people are in their natural environments. A goal is really to emphasize ecological validity and look at the microprocesses that influence mood and behavior in real world contexts at different periods in an individual's lives. EMA studies can be designed around capturing data at a short type of timeframe, like using a burst design where we may want to do some intensive repeated sampling over a two week period of someone's life. Maybe this would be just to capture a sample of a person's daily activities, where you're giving them multiple surveys a day for two weeks and asking them about their everyday functioning and behaviors, their mood, and their substance use behaviors. There's a myriad of different questions you can ask people during these sampling periods. You can also use it for more longitudinal assessments if you're looking to measure kind of change over time in certain things. If you're doing a more longitudinal EMA sampling period, you're probably going to want to have less frequency of surveys so participants aren't getting burned out - maybe sampling people once a week or once a month, with shorter little assessment periods scattered within there.

John Bellone 06:30
You have full control over the frequency of testing and even the time of day that you send out these push notifications, or make it based on different events, right? You have full control over those variables.

Raeanne Moore 06:43
Yeah, absolutely full control. Researchers or clinicians who are using EMA can write all the questions, design exactly how they want them to be pushed out and when. We usually send them out - I schedule them to be around a person's sleep-wake cycle. So if, say, John you are a "get up at 7am, go to bed at 10pm person."

Ryan Van Patten 07:07
[laughs] He's not.

John Bellone 07:08

[laughs] I'm not. But Ryan is.

Raeanne Moore 07:10

Yeah. Then we would schedule the surveys to be administered during that period of the day for you. For Ryan, if you're, well, it's the opposite, I guess. [laughs] You get the point. Also, we can employ branching methods. So if you respond one way to a certain item, then it would branch to different follow up questions along that same line of questioning versus if you respond another way it has additional follow up questions that go a different way. That just reduces the length of the survey while capturing the data that you're really interested in capturing.

John Bellone 07:18

You mentioned ecological validity. That's really just the degree of real world testing. So, if someone's in their natural environment, at home, that's as close to the real world as we can get, rather than them being in our office, which is a much different environment. We're further from that ecological validity in our offices compared to when they're at home. I just wanted to hammer that in as well.

Raeanne Moore 08:12

Yeah, absolutely. It's all about gathering data in the real world, in a person's everyday life as they're going around their everyday activities. Whether they receive a survey when they're riding on the bus, or they're cooking dinner, or they're at work, or they're at the gym, we can really capture the real world context around the behavior we're trying to measure.

John Bellone 08:35

You mentioned using smartphones. Can you tell us a little bit more about the technical and methodological side of data collection? Just high level, what does this look like?

Raeanne Moore 08:44

Yeah, absolutely. With the widespread smartphone ownership in the world today, technically, it's really fairly easy to integrate EMA into clinical practice or to research studies. Gathering the data is pretty simple and straightforward. There's several HIPAA-compliant commercial grade platforms available. They're relatively inexpensive and allow you to go in and customize them in any kind of way you would like to. They can be pushed out via a web link, which is nice, because that's

platform independent and could go to an Android or an iOS device without having to worry about the operating system that the device is running. There's some that are app-based, which are nice, because you don't have to worry about internet connectivity. But sometimes the app-based ones are limited to only like an Android or an iOS device. They can be pushed out via text messages. So there's a lot of - it's much easier than it was a few years ago to technically integrate EMA into our work, which is great.

Then you also asked about the methodological side of EMA data collection. In designing these studies I don't think there's a right formula in terms of frequency and duration, as we're talking about a little bit. It really needs to be done on an individual basis and just thinking about what questions you're looking to answer with this data. There's a couple of ways that we can assess and design these studies using EMA data. One has what we call event contingent assessment. Event contingent means it's linked to a particular event. To give an example, if you're interested in gathering data around daily stress behaviors, say a person receives an EMA survey, you set a threshold for what would be higher than normal stress for them. Or they respond that they're having higher than normal stress. Or maybe they're about to engage in a stressful situation like going to a job interview, for example. Based on how they respond, that could trigger the system to then follow up with a series of other questions all around that event. One cool thing too now is event contingent responses don't even have to be triggered by other EMA responses. You can integrate EMA with all kinds of other sensors that people can wear on their body or that are built into the smartphones. So, for example, there's these cool new wrist worn wearables that are a passive way to collect alcohol levels in your blood. Have you heard of these? So you just wear this wristband, and it, based on skin conductance, I believe is how it works, it tells you your blood alcohol content level. So, for example, if you were going to design an EMA study around alcohol use behaviors, you could set a threshold for whenever your blood alcohol content reaches, say, 0.08, it triggers an EMA survey asking a bunch of questions about alcohol use behavior. You're able to get that information in real time, hopefully eliminating some recall and state dependent biases that we tend to get with our traditional methods. Because we're really focused on asking questions about what's happening in the here-and-now versus what was happening in the then-and-there. It's kind of how I like to think about it.

John Bellone 12:06
Right. There's no retrospective bias. They're not having to remember how they were feeling yesterday. They're just answering based on right now.

Raeanne Moore 12:13

Yeah, absolutely. Then another way to design studies, and this is how I've done a lot of my studies to date, is just really doing a random sampling of behavior. So as we were talking about, maybe if you wanted to sample daily activities over a two week period, I would send out four surveys per day just asking about daily activities and mood and sleep and pain and other behaviors, just to really get at kind of a representative and unbiased estimate of the participants typical state that I'm looking to measure. Thinking about how using this kind of random, short time sampling can be really helpful, it's actually been starting to implement more and more clinical trials. I think we're going to see an uptick in that based on the current need for remote assessments, more so than ever with our current COVID pandemic. You could get a sample behavior at the onset of a clinical trial and after, and then aggregate those results and compare a pre and post. Another cool way to use it is you could actually be monitoring someone over time over the course of a clinical trial to actually see when the treatment that you're giving has the most effect. So, maybe it's having an effect after six weeks, maybe it's only after one week, maybe you started a new medication and within a day, one participant had some kind of symptomatology that went away after a few days. This is a good way to answer those kinds of questions using this methodology.

I guess the final thing I want to point out regarding methodology with EMA is, when we're designing studies, we want to think about different populations in terms of adherence rates. I usually work with clinical samples, so people with serious mental illness, people living with HIV, people with cognitive disorders. We have fantastic adherence rates. In our study, actually, people complete about 70 to 80% of the surveys we send to them. I think there's three reasons for that. The first is, one, we compensate people for surveys they complete. There's a little extrinsic reward they're getting there. We give them $1 for each survey they complete. The second reason for that is I think our staff are really engaged with these participants and they monitor in real time when people stop responding. They can call and check in, do some little motivational interviewing with them, and really help keep them engaged. The third reason I think we have been getting such great adherence rates is probably a bit of a sampling bias in that some of these people who are interested in enrolling in our studies already are intrinsically motivated to contribute to research, to move the field forward, want to help other people in similar conditions, so are really motivated to do what the researchers have asked of them. Versus people who are non-clinical samples, we see a lot of the times much worse adherence. It's in the 30 to 50%. When I think about my own adherence rates - I always test my own protocols on myself before I implement them, and my adherence rates are terrible. [laughs]

Ryan Van Patten 15:26

[laughs]

Raeanne Moore 15:27

They're probably like 20%. It's so bad. But because usually the survey goes off and I'm in a meeting, or I'm commuting, or I'm on the phone, or I'm taking care of my daughter, or whatever may have you. I just have a hard time fitting that in. One thing we've been experimenting with a little bit lately, in thinking about how to increase adherence in these non-clinical samples, is the concept of micro-EMA. Instead of just administering your full two to three minutes survey, you're administering just one question at a time that just pops up on the homescreen of your phone, you tap or slide on a little scale and you respond and that's it. Or even a pop up on your Apple watch or other smart watch you may be wearing and you just tap it and respond. I think you're not getting as rich of data doing it this way, but you also make it more adherence and better able to capture data you're interested in in samples of people who will be likely to respond - I'm saying likely a lot. [laughs] But you'd have a difficult time getting responses from otherwise.

Ryan Van Patten 16:35

Yeah. I could see particular constructs being amenable to the micro-EMA - mood, anxiety, fatigue, a one question overarching construct that you're interested in. That could work well. I wanted to follow up on what you said about event based EMA as well. You mentioned the event of having a blood alcohol content at a particular level triggering a survey, which is very cool. I like tying those together. Something that came to mind for me was sleep-wake actigraphy. Could you do the same thing where you have an actograph of some kind of watch and when the person wakes up in the morning, you trigger an EMA assessment?

Raeanne Moore 17:23

Yeah, absolutely. Definitely it would be feasible to do that. We have already been linking actigraphy watches with EMA, but not at the event based way you mentioned, which could field some really great data.

Ryan Van Pattern 17:37

Yeah. So there's a lot of great content in what you've said already, Raeanne. We have several follow up questions. I'll start by asking you to briefly describe how you analyze EMA data.

Raeanne Moore 17:50

Yeah, sure. Analyzing EMA datasets can be really challenging. You're getting a lot of data, you're getting a varied number of observations per subject, and it's relatively unstructured data. Also, with the branching schemes I mentioned, you're getting different amounts of data in response to each of the questions and setting up that dataset for analyses can be challenging. But, once that's done, then there's a couple common ways that people like to analyze data generally. One is thinking about a data reduction method. Summarizing all the data you're getting down to a within-day or within-week assessment into one single measure. An example of when we did this, I was fortunate enough to work with some colleagues a few years ago where they did a mindfulness-based stress reduction intervention in emotionally distressed older adults. They had their mindfulness group, which was a treatment group, and they had a health education group, which was their control group. They were interested in seeing if different ways we administer the outcome measures would result in different effect sizes or treatment response to this study. They had the participants complete paper and pencil measures of mindfulness, depression, and anxiety before and after the treatment. Then they had people also complete two weeks of EMA of mindfulness, depression, anxiety, the same questions, but during an ambulatory monitoring period, pre and post. Interestingly what we found is that when we used the EMA to measure clinical symptoms, we saw that the older adults who participated in a mindfulness based stress reduction intervention had significantly higher mindfulness and significantly lower depression, anxiety after the intervention as opposed to the control group. But when we looked at just the paper and pencil measures, we did not see any significant changes in these outcomes. When you think about how many resources and time and energy go into these clinical trials, outcome measures are so important, the most important thing. This was just a really nice example to show that this sensitive measure we're getting by EMA has made a huge difference. Showed an effect when our traditional measures, when just asked at one time point pre and post did not.

Another way that I think it's a pretty cool way to analyze EMA data is to be looking at the within and between the temporal patterns in behavior. So, for example, if I wanted to look at the relationship between mood and, say, cognitive complaints, we could look at it at the same time. Maybe if someone's feeling depressed, they're also reporting that they're having difficulty concentrating. We could also look at, say, if someone is feeling depressed at time point one, maybe then later in the day, how does that impact their cognitive abilities? You can look at that within-day and between-day within people and across people. Multilevel models are usually the analytic technique that's used to do that. I'm not going to get into the details of analytics. [laughs]

John Bellone 21:23
That's sufficient for a high level.

Raeanne Moore 21:25
High level. Yeah. [laughs]

John Bellone 21:26
It seems like one of the big strengths here is that we have a lot of within-subject parameters and data because usually we're just looking at between groups. But here, if you're repeating these measures dozens of times with the same person, you're getting a lot of within-subjects data. You can really look at that person, how they fluctuate based on day of the week, time of day, close to their lunch or not. I mean, you can have so much data there.

Ryan Van Patten 21:54
Circadian rhythms that we could never test before.

John Bellone 21:57
Yeah. I really like that aspect of this. You mentioned the MBSR intervention on mindfulness. Can you give us a quick overview of the literature in other clinical populations? Where are we at right now in terms of EMA in general?

Raeanne Moore 22:12
We've learned a ton about the relationship between affective behavioral and contextual experiences across various clinical and non-clinical populations. For example, people have used EMA to look at the relationships between post-traumatic stress disorder and alcohol use. People have used it to look at early risk factors for psychosis. There's quite an EMA literature on using it to look at the context around suicidal ideation and behaviors. For the interested listener, Matthew Knox is really the leader in the EMA for suicide research. He's written some wonderful papers on the topic and it's been used to measure post-surgical outcomes, effect of psychopathology, pretty much it's been used to look at a lot of interesting relationships that we just previously weren't able to look at in all kinds of clinical populations across the board. We even have studies now - I'm a consultant for a study where we're using it in kids with eating disorders. We're able to use it cross-culturally and in other countries, low and middle income countries, where we weren't able to conduct data-rich studies before. That's where it's at right now. And it just continues to evolve over time.

Ryan Van Patten 23:37

It sounds like it's very applicable across different clinical populations. Are there any clinical groups where you would say EMA is not appropriate?

Raeanne Moore 23:46

That's a good question, Ryan. We've found that most people are able to do it. Most clinical groups, even people with Alzheimer's disease and dementia are able to do it. I feel like we write these grants to use smartphones - and Alzheimer's research is something that is very near and dear to my heart - and reviewers always come back and say older adults or people with cognitive problems cannot do EMA. And that's just not the truth, as we know.

Ryan Van Patten 24:20

Yeah. But that's a great benchmark to use. I was thinking about older adults, people who have trouble with technology or aren't used to it. If you can, if this works in older adults who have varying levels of AD, then I can't think of a clinical group where it would not potentially be applicable. This is a great segue on EMA for socioemotional symptoms or diurnal rhythms, as we've been talking about, to moving into EMA to assess cognitive functioning, which we might call mobile cognitive testing, or MCT. My understanding is that the literature on mobile cognitive testing is smaller than EMA for emotional symptoms. What do we know about mobile cognitive testing to this point?

Raeanne Moore 25:06

I'll share a little story with you about when I first learned about mobile cognitive testing. I was still a postdoctoral fellow working on my K award. For those of you who don't know what a K award is, it's an early career development award to fast track a researcher's career from postdoc to an academic faculty position. We had a colleague, Joel Swanson from the University of Bordeaux in France visiting. He told me about a paper he had just published, where they created a mobile cognitive test that they modeled after the Wechsler similarities test. So people on their smartphone would see four things like fall, winter, spring, summer, and then had to type in how those constructs were related. For that example, seasons would be the correct answer. They were administering these on a smartphone. This is the first I'd heard of this. The participants they had were community-dwelling older adults - the mean age of their samples is actually 75, so a much older sample, but a healthy non-clinical sample. What they did is, at baseline, they had their participants complete a comprehensive neuropsychological battery, as well as an MRI. Then they followed that up with seven days of a combination of EMA and mobile

cognitive testing. They did it five times a day where they'd get these EMA surveys five times a day that asked about the participants' daily activities - what are you doing, who are you with, all these kinds of things. Then after two of those five surveys each day, they would receive this similarities test. They didn't know when they were going to receive the test, they just knew it was going to come after two of the five surveys that day. When they went to analyze the data, they found that there was no significant association between the lab-based neuropsych test and hippocampal volumes in these folks as measured by MRI, but they did find association with the aggregate mobile cognitive test score and hippocampal volume. Then they went on and they did some of those lagged analysis that we were talking about a little bit ago. They looked at the relationships between the EMA daily activity report and the mobile cognitive testing performance and they found that if a participant was engaging in an intellectually stimulating activity, so doing a crossword puzzle, or reading, working, any kind of what they categorize as intellectually stimulate activity, that predicted their future semantic memory performance later on the same day. So intellectually stimulating activity led to better memory performance later on the same day. When I heard about the study, I was like, "Holy moly, this is going to be a game changer for the field." That was my thought. I really thought that traditional neuropsych tests don't allow us to examine this dynamic interplay of cognitive function and behavior in real time. I was like, "I've got to get in on this." So a few months later, my K was luckily funded, and I was able to integrate mobile cognitive tests into that study. So, I was able to capture this data myself. I went to a conference, I won't say which one [laughs], the next year and I presented some of these little findings - I was so excited about it. There were traditional neuropsychologists in the audience and they said, "This is not neuropsychology. What are you doing?" Very dismissive. I just kind of took it with a grain of salt. I was like, "No, they're going to come around." [laughs] And, sure enough, interest in mobile cognitive testing has really grown. There's been growing evidence that these mobile assessments have good psychometric properties. Investigators are wanting to increasingly use mobile technologies to complement traditional neuropsych assessments. As evidence of this, we just had a whole symposium at INS 2020 on mobile cognitive testing, which when I first submitted this symposium I'm like, "I don't know if they'll accept this. Is this too disruptive right now?" They were enthusiastic about it. It was well attended. I think that just shows a shift in the thinking in the field towards integrating these advances in mobile technology for monitoring cognition in the wild - that's such a catchphrase, "in the wild". [laughs]

Ryan Van Patten 29:22
Yeah.

John Bellone 29:22

Right. It is obviously a divergence from our traditional neuropsych testing in office, three plus hour battery and traditional testing, where now it could take two minutes to do a Similarities task in the person's home. It is different. And I can see why people will push back on it, but I think as what you've already alluded to, and hopefully our remaining questions will elucidate, there's definitely a lot here to be really optimistic about and excited about. Before we get into the details, though, can you tell us a little more about the type of tests? Like what does this look like? Similarities is one. I know there are many other types of tests that can be adapted to mobile cognitive testing. Can you talk through a couple of different tasks that you use?

Raeanne Moore 30:12

Sure. The first tasks that I did were modeled after traditional neuropsych tests. So, for my original study, we had a mobile version of the Stroop, which we called Mobile Color Word Interference Test, or as we lovingly call in the lab, the McWIT. One of my graduate students named it that, which I think is a very catchy name. For that task, people are presented with a list of color words on the phone that are in a different color ink [and] as quickly as possible, they have to say the color and not read the word. We also had originally a mobile verbal learning task modeled after the HVLT. We created some new word lists because of copyright with a lot of existing word lists. People had 30 seconds to memorize the words, then it went away, then they had to state back all the words they could remember. You had a couple of different learning trials of that.

Now I've been moving more into developing some newer, more gamified tests and things that are a little more fun and engaging for people to do. Not just a replication of a lab based task but tests that we think will measure the same construct that we're trying to measure in the lab, but that just have a little more fun and engagement along with them. I've worked with some human-centered design folks over in our design lab and just really taken that human-centered design approach to develop some of our new tasks, which we have one - I know you guys might be too young, I don't know if you remember the game Simon. It was a little handheld game, and different colors would pop up, boop, boop, boop, boop, you have to repeat the sequence. So we have one that's modeled after that. It has sound with it and people get some feedback in terms of their performance. The feedback is a bit arbitrary to people. But it's nice that we're able to say, like, "Look, you got 11 right this time", "You got 12 right here." We've been evolving. That's how I see the fun in this is evolving it to some different tasks, but measuring the same constructs, and then validating them of course against lab based tasks. I'm so sick of seeing all

these - there's so many new current testing platforms that come out and I can't tell you how many times I've seen replications of Trails A. I think this is an opportunity to be more creative. Asking people to do repeated assessments of cognition on their phone multiple times, which is how I define mobile cognitive testing, we want it to be something that they're going to engage with and that's fun for them and gives them some kind of feedback as well.

John Bellone 33:04

It can be gamified like many of the other apps. The world's your oyster in terms of what you want to tap into, what type of task. There's so many different ways you can modify this.

Raeanne Moore 33:14

I would love to actually be able to use Candy Crush as a cognitive test. [laughs] I feel like there has to be something there. There's that addictive quality. It's bright and shiny, right?

Ryan Van Patten 33:25

People complain about the fact that they can't put their phone down because they're playing this addictive game. We should capitalize on that and capitalize on their addiction, but make it too a neuropsych-ish test. I wanted to speak to your story, Raeanne. I think Bob Bilder might describe what you experienced as the inertia in our field, which has been a challenge for those of us, you certainly, who are pushing the field forward. Of course, we don't want to blindly accept computerized testing or mobile cognitive testing without sufficient research on it, but you're doing the research right now. So thank you for your work in this area. I think it's all really exciting.

I think moving forward in our conversation with mobile cognitive testing, it'll make sense for us to compare it to what neuropsychologists know very well, which is in-person paper and pencil testing. There's a few ideas or parameters of EMA that we've already discussed that I'd be interested in hearing you compare mobile cognitive testing to traditional neuropsych testing across these dimensions. So, for example, MCT allows us to collect a lot more data, which as you said, can be aggregated together. You might have one number, one parameter, that represents someone taking a mobile cognitive test 10 times and then you compare that to in-person testing where they were in the lab, one time sitting down and going through neuropsych testing. In general, what are the correlations or how do you compare MCT to conventional neuropsych testing.

Raeanne Moore 35:03

I want to clarify, because I don't think I made this clear before, that when I'm talking about mobile cognitive testing, I am referring to self-administered cognitive tasks on a smartphone or another mobile device. There are several web-based or other teleneuropsychological tools out there, which are administered very differently and designed for different purposes. So, just to be clear that I don't see mobile cognitive testing as a replacement by any means for traditional neuropsychological evaluations. But I think about traditional neuropsychological testing as measuring a person's cognitive capacity.

So, Ryan, kind of to get back to your question about how we do it. In a lab, it's in an ideal environment - there's no distractions, you're one to one with an examiner, we're getting that capacity, how well their brain is capable of performing. Whereas for mobile cognitive testing, I see this as measuring cognitive performance. This would be your cognitive abilities within the context of your daily life. How is my cognition when my toddler is demanding all of my attention, which happens all the time, [laughs] or when the TV is on, or when you're riding on a bus, or how is my cognition right now when we're being flooded constantly with alerts from the news about this fluid COVID situation and the stress induced around that. Really trying to capture cognitive performance in the real world without trying to exclude all of those contextual factors. That's what we're interested in trying to capture around it.

John Bellone 36:45

There are a couple big applications that I could see working here. One of them is the comparison from in-person [testing] to a home-based environment. Very often I get a patient, an older adult, who's complaining of memory problems. They come in, and they do great on my testing, but they're still having symptoms at home. I have to explain how my test is in a very structured environment. It's not chaotic like their home probably is if they've got the TV on, they've got their meal in the microwave, they've got several different things to attend to. It'd be so nice if I had both sets of data. I could see, "Okay, well, in my office, you do great. At home, you're not doing so hot on the cognitive testing. That's clear evidence that it's distraction that's causing it." That's just one application that I can see.

The other application of this is potentially as a screening tool. I'm thinking of maybe a large medical group that has maybe 5000 members, and the neuropsychologist is getting data from all of these members, maybe everyone, when they join this medical group. They do a five minute cognitive screening, maybe once a month they do this, and then a psychologist gets all this feedback, all this data. Then based on that data, they can decide who should get a comprehensive

neuropsychological evaluation. Maybe there's some threshold that they meet in the data, or maybe they're actually monitoring everyone. This is just a percentage of the neuropsychologist's job to monitor the mobile cognitive data and select who goes for a full evaluation. I wanted to get your thoughts about those.

Raeanne Moore 38:21
I think we're not quite there yet.

John Bellone 38:24
Yeah. Right. I should have said that right up front. [laughs] This is in the future. These are just some of my thoughts.

Raeanne Moore 38:31
To get back to Ryan's previous question about the psychometric properties a little bit. We are finding that, at an aggregate level, these mobile cognitive tests, at least the ones I've been using, have been correlated with the constructs we think they should be correlated with in the lab. Our tests that are designed to measure verbal memory are moderately related to the lab based. That's what I would expect. I wouldn't expect them to be perfectly correlated because they're not measuring the same thing. As we talked about, measuring cognition in context versus measuring cognition at one time point in the lab and maybe, just maybe [laughs], the in-person [testing]. An aggregate over multiple assessment periods of the same cognitive task in different contexts in people's daily life. Maybe they take it once when they're freshest in the day, which for me is usually after my first morning cup of coffee, three cups of coffee. [laughs] Then you're taking it again like mid-afternoon when you're having distractions and you're a little fatigued. So that aggregate might actually be more indicative of real cognitive ability than the snapshot you're getting in the lab which may have been the person's best performance, but it may also have not been their best performance. Maybe an airplane flew over during a couple of key tests, or their phone kept - this happens to me all the time. My watch keeps buzzing, someone keeps calling or there's other distractions that are happening, and you're only getting that snapshot. That's a bit of a long winded way of saying that the psychometric properties are looking really good, but they're measuring a bit of something a little bit different.

To get back to the screening tool, there are currently some screening tools out there that have been performing pretty well that are web-based or app-based that were designed specifically for the screening purposes. These are designed to be administered when someone's at home, but maybe you schedule [it]. When you're

going to take it, you sit down at your computer, you shut the door, it's quiet - kind of mimicking a lab based environment. I think mobile cognitive testing could absolutely in the future be used to monitor cognition over time. For clinicians to help people do it and for people to empower themselves to do cognitive checkups. Take these regularly. As you mentioned, John, looking for some thresholds in the data, where there's a change and notable change. You have to think, though, - well, I have to think about what's the baseline? What are we comparing to? The big question that keeps coming up currently in the mobile hardware testing world is do we have the norms? What do those norms look like? Are you still comparing people to other demographically matched people who are the same as you? Or are you using yourself as your own baseline and comparing yourself and your change over time, and that variability that you have to yourself? I think that this could be a way, as a field, we could add a lot more value. To be able to follow people over time. Try to identify cognitive change, using these mobile cognitive tasks.

I've been also doing work with passive metrics, which I talked about a little bit at the beginning. Passive data is collecting data continuously, unobtrusively in the background, to see if there's some passive indicators of cognitive change just by how we interact with our smartphones. We've been collecting keystroke data by how people type on their smartphones, not what you type, but how you type it. So the use of backspace and enter key delay, speed of typing, autocorrect features, it's just all these metrics you have in the background. We're finding some exciting evidence that that may actually be related to your cognitive abilities. So maybe we could get to the point in the field eventually where we don't even have to use an active task to screen for people who are in need of coming in for earlier assessments. I see a lot of clinical utility there because thinking about people with Alzheimer's disease, for example, usually they don't get referred for neuropsychological assessment, as you well know, until they're symptomatic. If we can start monitoring their cognition much younger in their life, over time identify change early, get them in for a traditional diagnostic assessment at that time, get them in for a neurology exam, etc., we could implement treatment much earlier. The current treatments seem to really only be effective before someone's symptomatic. So I think this could be a way we could really make a difference in helping people prevent or stave off future cognitive decline.

Ryan Van Patten 43:13

Yeah, on that very topic, I believe you're involved in natural language processing, which could be used to analyze the language, the speech patterns of older adults and potentially identify early AD. What do you think about that?

Raeanne Moore 43:27

We were fortunate enough, my colleague, Dr. Erin Sundermann, at UCSD and a few other of us to get a new grant from our UCSD Shiley-Marcos Alzheimer's Disease Research Center, where we're going to be using natural language processing to see if it can be a digital biomarker for Alzheimer's disease risk. We're going to be sampling free speech. We're just going to be asking participants to tell us a story. We'll give them parameters around that story, but we'll just be able to get a brief five minute sampling of behavior. Then we're going to use advanced computer techniques, such as machine learning, artificial intelligence, and we've partnered with some wonderful colleagues in computer science who specialize in this natural language processing and these advanced computer techniques. We're going to be examining the linguistic characteristics, the grammatical patterns, etc, from these transcriptions. We're going to do this in a well characterized sample, so the ADRC. We're going to be able to implement this in every person, it's going to be added on to their regular visit. So we'll know if someone is cognitively normal, has mild cognitive impairment, has Alzheimer's. We'll be able to see if just by looking at these speech patterns from a free speech sample, we could classify people into a diagnostic group. We're not the first group by any means to be doing this. There's lots of people who are looking at this right now, but it's just another example of how we can utilize technology to really try to improve our assessment of cognitive abilities.

Ryan Van Patten 45:00

If NLP becomes advanced enough, I can see that being an incredibly efficient and effective way to identify early AD - word finding difficulties, trouble with semantic memory, where you're using more of a superordinate word like animal instead of more specific word like ostrich, we could potentially detect early breakdowns in different neural processes passively. This doesn't require an active effort by the participant.

John Bellone 45:33

Seems like there's so many different forms of passive data collection. You mentioned GPS much earlier, too. I wanted to ask you about that as well. Tracking someone's movements. Also the other one is the Internet of Things. We talked to Dr. Bilder about that - how your car, your fridge can all send you data, potentially. This is again in the future, but there's so many different ways to look at someone's cognition in creative sorts of methods.

Raeanne Moore 46:01

We've been using GPS in several studies. We just installed a GPS tracker on someone's phone, we make sure it's HIPAA compliant, of course, because you definitely have to worry about this highly sensitive information. We just track that as they go about their study period, where they're doing EMA, mobile cognitive testing, and things like that. A GPS is also referred to as an assessment of life space, especially in the gerontological literature, as people have referred to this kind of data. In the first paper that we published looking at the relationships between GPS and mood and affect in people with schizophrenia, we had a large sample of people with schizophrenia, as well as a non-clinical control group. They did EMA assessments as well as had GPS in the background. We found that less GPS mobility, so spending more time at home, as we can all relate to right now… [laughs] Less mobility, more time at home, [had the] worst negative symptoms in these folks. The less time you're spending at home, the better your mood was.

Ryan Van Patten 47:16

That makes sense. They're out in the community, they're visiting friends. Of course, none of this applies right now, as you said, it's good that we're home, social distancing, etc. In a typical environment, it's healthy to be active and out and about.

Raeanne Moore 47:32

We recently just finished analyzing some other GPS data that we had from a study of middle aged and older adults living with HIV, with and without cognitive impairment. They did 14 days of EMA and mobile cognitive testing as well as we tracked the GPS in the background, and we found that the persons living with HIV were spending more time at home compared to the persons without HIV. And that, across the board in every participant, more time at home was related to lower happiness, which, again, [laughs] is very relevant to right now. But on a positive note, when we added covariates into that model, impact of social interactions attenuated the effect of the relationship between being at home and happiness. Such that as long as you had a decent amount of social interactions in the day, spending more time at home didn't result in lower happiness.

John Bellone 48:32

Like a phone call or FaceTime with your grandkids. Something like that.

Raeanne Moore 48:36

Absolutely. Virtual happy hour... [laughs]

Ryan Van Patten 48:40

Which is scheduled for right after our conversation with you... [laughs]

Raeanne Moore 48:42

John, you were asking about the Internet of Things and when we get into this, like, "Oh, do we want sensors in our homes?" Like, it could be on our fridges, on our stove, on the door, on the garage door, in the car. The question that I keep asking myself here is, "How much do people really want to be monitored?" Well, actually, people hate the term "monitored", I found. They prefer "tracked" or some other thing. It feels a little big brother-y. But I think I'm like, "Are these just cool ways to collect data? Is it meaningful?" And I'm just not convinced yet, at least for assessment purposes, this is all that meaningful data. Some paper might come out next week and totally I'll be eating my words. It'll be this brilliant paper. But at this point, I think it's important to weigh the pros and cons of what people want - how much they want to be tracked in their daily lives and what meaningful data we can get out of it. Are we gathering data just to gather data, or is it helpful when thinking about assessing things via mobile technologies? At least I always know when I'm being monitored. If I don't want to have my Apple Watch tracking me, I take it off. If I don't want my phone to be tracking me, I leave it at home or I turn it off or I turn off the settings on the app that are tracking me. If it's in your home, it is a bit different. We all know Alexa is always listening [laughs] and recording all of our data. I mean, I have Alexa in every room in my house. So, I mean, that risk benefit to me is like worth having versus not. But I think about this in the Internet of Things era. The biggest benefit I can see is for aging in place research. Having sensors on the door if someone maybe has dementia, right? So you can monitor if they leave if they're not supposed to be leaving, or if they leave the stove on or shut the garage door - some of those kinds of things. I can definitely see it being very helpful, but I'm still on the fence about using it for assessment. I don't want us to fall into a pitfall of, there's just so many - like, "This is so cool. Let's just put sensors all over someone's house and track every movement they make inside their house in their daily lives." Yeah, I just don't know about it.

John Bellone 51:14

Right. We need to be very cautious about this. But the other side is that, like you said, with aging in place, this could increase someone's autonomy and independence if now they can live at their home as long as their adult child monitors the stove, like you mentioned, or their fridge, or are there other activities. This requires many discussions and lots more research. This is just the beginning of this sort of application. Privacy, I was going to ask you about that. You had

brought it up. Obviously, everyone in your study consented to having you guys track their GPS data. Was privacy ever an issue? Is there ever a chance that it could be used for marketing or other less than desirable sorts of purposes?

Raeanne Moore 52:02

Absolutely. Privacy is always a concern. It's something that's always first and foremost on my mind when I'm designing studies and deciding what apps or other technologies to use to gather the data. We know that our devices at all times are already collecting and analyzing all of our data for targeted marketing. We have to sign those horrific consents to even use our iPhones, right? We don't even know what we're consenting to. But, basically, we're sending them taking all of our data and using it for targeted advertising, which can be kind of nice. It's like, "Oh, I think you'd like the sale at Nordstrom." I'm like, "Oh, yes. I would." [laughs]

John Bellone 52:36

[laughs]

Raeanne Moore 52:36

They're using it for those purposes. We have to be really careful. It has been less of an issue with active data collection because a person knows exactly when and what data is being collected. For the most part, I feel like it gets a little more ambiguous in terms of passive data collection that's kind of always occurring in the background. There's a lot of existing apps that we could use to collect passive data, which if you actually read the fine print of their terms and services are selling the data to companies or selling it to advertising firms. These are not things we're going to want to be using with our patients or research participants - things I don't want to use. We just have to be careful in terms of what we're using. But, by and large, if we are using a privacy preserving and HIPAA compliant tool, I think the benefits can largely outweigh the risks.

John Bellone 53:36

Just to talk about some of the other potential limitations to mobile cognitive testing and EMA. I wanted to ask you about test security too. I'm sure that comes up for people hearing about delivering a Trail test or a Stroop test on a phone. They can take a screenshot or they can record it. How do you deal with that?

Raeanne Moore 53:58

It's really difficult to control for test security and cheating.

John Bellone 54:02

And cheating, too. Yeah. Good point.

Raeanne Moore 54:04

For the most part, we've developed all new tests. At least the ones I've used because a lot of the existing ones they're copyrighted. They're owned by Pearson or PAR or somebody else and you cannot replicate them. There's the issue of it from that level. Then getting into security, how I like to design my mobile cognitive tests and studies is they get a different version every single time they take it. That's one of the benefits of using technologies, you can always have a different version of the test. You don't have to worry about the content being copied or things like that. It's just a risk you're willing to take.

The cheating thing gets tricky. And [laughs] we actually had someone - so I mentioned our McWIT, our Stroop-type task, where participants had to read the color of the ink not the word and they were audio recorded. So we had our research team listen to all the audio files to score these tests. There was one point when I heard someone say, "No, you just say the color of the ink. You don't read the words", and someone else was like, "Wait, what?" And then, "You just read the color of the ink." And other person's like, "Oh. Then that's blue, green, yellow." Okay, obviously, [laughs] not the person that we intended on taking the test is taking this test right now. That gets tougher. We've moved away from the verbal responding tests to just touch response tasks because of use for scoring and things like that. How do you know that the person who's taking it is the person that you intended to take [it]? I even had a colleague sample some out recently. "Oh, yeah, my daughter was playing on my phone and one of your surveys popped up and she just took all the tests."

John Bellone 55:40

Oh, great. [laughs]

Raeanne Moore 55:41

How would we be able to differentiate that? Sometimes you can identify a digital fingerprint underlying test performance. It's also sometimes you get into these limitations of differences in devices. So having the iPhone Plus versus a smaller iPhone or smaller Android phone. If you're thinking about a process, it's a reaction time test, just the size of the device is going to make a difference in terms of overall performance. Internet connection speed can make a big difference. Is someone using one or two thumbs to respond? That's going to make a difference in how fast

you're playing. All these things or limitations that can impact scores. There are things we can look at as much as we can, but we're still figuring out how to best deal with all of these things.

Ryan Van Patten 56:29

I wanted to make a brief comment on the privacy discussion, which is to say it was helpful. There's so many ethical dilemmas, so much to think through when we consider some of this new technology in healthcare, for example. Then, in general, we're not even talking about social media use and stuff like that. If listeners are interested, I would say Justin Harris [is] someone who does great work in this area and some more depth than we're able to go into today. I would say look at his work.

I just wanted to say, Raeanne, we've been asking you a lot of questions about a lot of things. We've kind of been all over the place, so thanks for sticking with us. We talked about EMA, mobile cognitive testing, natural language processing, and the Internet of Things. There's just a lot of tools in this area, all of which are exciting and up and coming.

I did want to clarify one thing we had touched on earlier, I'm curious of your opinion. You mentioned in terms of mobile cognitive testing that a big question is, do we need norms for this? Or can we just use the participant, the examinee, as their own comparison? I don't believe you shared your opinion. I'm curious what you think about that issue?

Raeanne Moore 57:43

I didn't share my opinion. [laughs]

Ryan Van Patten 57:45

Maybe that was intentional. [laughs]

Raeanne Moore 57:48

I think there is a lot to be said about looking at interindividual variability over time. I think if we can get to a point where we can start doing these regular cognitive check ins with people where they can be self-monitoring their cognition on a regular basis, maybe once a month or once every six months, doing little bursts of mobile cognitive testing that really the most meaningful changes we might see might be within that individual.

Ryan Van Patten 58:19

That makes sense. In my own daily work life, I put a lot of effort into monitoring and capitalizing on my own cognitive rhythms. So, for example, I try to have a sense as to when, during the day, I'm most likely to be focused and efficient and then I spend that time working and I save R&R for other times of the day. We joked earlier that I'm more of a morning bird and John is a night owl. So, many people do this. Some of us really try to put effort into finding those periods of time during the day when we can be most efficient, working at that time, and then spending leisure time at other points during the day. I'm wondering to what extent we might be able to use mobile cognitive testing to help identify and quantify our own cognitive rhythms even in healthy populations.

Raeanne Moore 59:07

I really like your use of the term cognitive rhythms. I think that's cool. I haven't heard that before. I think a lot of people want to really be actively engaged in our cognitive health. I mean, just as you've seen, the world has embraced tracking so many aspects of our behavior. We wear watches, a tracker, of physical activity and our sleep. We track our eating behaviors. We track our smartphone usage, all of these different things. If we can have cognition just be another one of the things we're able to track, I think there would be a lot of interest in that. One thing we have to be careful when considering is what data to give back to people and that could be personalized on an individual level. So, thinking about the data we get back from fitness trackers, for example, normally we just get back the aggregate daily step count or my calorie expenditure from the day and I'm happy with that. That's all the level of detail I would want to get. But there may be some people who would be a data junkie, or some would want more in-depth data there - cognitive performance and its relationships between their mood and diurnal rhythms and behavior and cognitive abilities and all these things. We could get to a point where we could personalize this feedback, that could be pretty cool.

I think we need to be really careful about, we don't want to diagnose people from a mobile cognitive test. This is a pitfall I've seen some of my engineering colleagues who don't have a psychological background fall into. They're like, "Oh, we have this big screen pop up to say, 'You have Alzheimer's!'", I'm like, "Oh, no. No." This is not replacing a traditional assessment. We have to be careful about that too. But this could really open up the door for these kinds of cognitive checkups or other opportunities in our field. One thing that comes to mind would be a cognitive rhythms analytics concierge service, [laughs] that'd be cool. Something where you build a business around servicing executives and other high achieving of the general public, anyone who's interested, they track their behavior or context

cognition, you give them a personalized report of when their cognition is going to be the strongest and when they should be working, when they should be resting, etc. It's just an idea kind of off the top of my head. [laughs]

Ryan Van Patten 1:01:38
Right.

John Bellone 1:01:38
There are already life coaches and companies that are trying to do that, who are non-scientific, and I think we would be potentially the best fields to put a data driven approach to that sort of intervention that you mentioned.

Ryan Van Patten 1:01:54
We might marry neuropsychology with IO psychology for this purpose. In terms of, you've hired someone for a job, they're a programmer, for example, and they can work at any time and it's beneficial for them and the company if they work at a certain time of day. You'd want them to be as efficient as possible. Could be an early intervention or assessment that is done before someone's work hours are suggested. Something like that.

Raeanne Moore 1:02:21
Yeah, absolutely. Or identifying a new hire, how they work best.

Ryan Van Patten 1:02:27
Yeah.

Raeanne Moore 1:02:27
For me, I don't work well in a big open environment with lots of distractions because I get easily distracted. I need my own office where I shut the door and just focus. Being able to identify some of these things in individual employees, for example, I think that's a great example of, an IO psychology example, [how you] could maximize performance and maximize the benefit you're gonna get out of these people.

John Bellone 1:02:51
It could also help us potentially reach people who otherwise wouldn't have access to neuropsych testing, right? The people who have low SES or people living in rural areas. It's another application potentially.

Raeanne Moore 1:03:03

Oh, absolutely. I think that's one of the things I'm most excited about when I do work with mobile cognitive testing. Because there's so many limitations to receiving a neuropsychological evaluation. So many people are limited based on the location they live in. It could take four hours to get to the closest neuropsychologist in their state. Insurance restrictions. There's language barriers. Do you guys know that only - I just heard of this statistic that only 2.8% of board certified clinical neuropsychologists in the US speak Spanish. 2.8.

Ryan Van Patten 1:03:39

That's terrible.

John Bellone 1:03:42

That's probably Monica Rivera Mindt. [laughs]

Raeanne Moore 1:03:44

[laughs] Right. We could name them.

John Bellone 1:03:48

Probably. Yeah. Unfortunately. It's really unfortunate.

Raeanne Moore 1:03:52

It's terrible. So just thinking about opening up the possibility to reduce these disparities in health care. I mean, today, 3.5 billion people in the world have a smartphone, about 45%. It's predicted that by 2021, more people will have a smartphone than will have bank accounts, running water, toilets. This is crazy to think about. Can we capitalize this to really reach segments of the population that we've historically been unable to reach?

John Bellone 1:04:24

Yeah.

Raeanne Moore 1:04:24

We just put in this grant to conduct integrated EMA mobile current testing down in Ecuador, where we would be assessing adolescents who have been being followed and using traditional methods for the past several years. We can assess their mental health and their cognitive abilities, and the complex, dynamic relationships

between all of these things in relation to pesticide exposure in this region. That's just one example of how I can see this being really helpful.

John Bellone 1:04:58

We talked about how, for clinical neuropsychology, this is obviously a way off to really fully incorporate it into our practice. I think it's good to start thinking about it and start doing the research like you clearly have been doing. In terms of researchers who want to start looking into using this technology, where would you point them in terms of getting started? I know you mentioned NeuroUX. I don't know if there are other platforms that you recommend.

Raeanne Moore 1:05:30

Yes. So NeuroUX is something that was developed out of the grant that I received. So that one is, of course, I'm biased towards, but we're still validating it. [laughs] John Torres has developed one out of Harvard. Some of you may know John. I'm also involved in the Mobile Toolbox project. So the NIH has funded a huge project where they're developing a mobile version of the NIH Cognitive Toolbox. They're going to be norming it with thousands and thousands of people. Ready to roll out in a couple years. Jason Hassenstab has developed a great platform that he's been using in multiple different countries. There's a handful of us who've developed platforms that we've been using. My guess is there's lots of people just building in-house tests on their own as well, and testing them out.

John Bellone 1:06:25

Great. Lots of options for researchers.

Ryan Van Patten 1:06:28

What do you see as the path forward? If you were to project five years, 10 years from now where will the literature be? How soon might we be able to ethically, competently start incorporating mobile cognitive testing and EMA into neuropsych practice clinically?

Raeanne Moore 1:06:46

There is really a huge boon right now, I think, for trying to validate some of these passive metrics we talked about. Bill Gates is funding a diagnostic accelerator specifically focused on identifying digital biomarkers for cognitive change. I can really see if we can get some traction on some of these passive metrics being related to not just related concurrently to cognition, which we have some of that

data now, but could actually be predictive of change. I could see that happening easily in the next five years. That would provide compelling tools that researchers or clinicians could probably pretty easily implement. We're at a place in society where we can gather tons of data in large samples of people using open science type models, if we really did want to gather some of that rich data. Some of the problems, though, with open science models, I think, are if you're not bringing people to a lab, what are you validating things against? We still need to have that gold standard. But I do see the passive data collection method really taking off. I also see people getting more and more entrenched in the mobile cognitive testing world and really looking at this kind of cognition in context and developing interventions around that. I see that happening in the near term as well.

John Bellone 1:08:18

Excellent. Well, we have a couple bonus questions for you before we wrap up. It might be helpful for these questions if we know how you identify professionally. You identify as a psychologist, neuropsychologist, neuroscientist? I know these are very blurry lines between those.

Raeanne Moore 1:08:34

Yeah. I identify as a clinical neuropsychologist. I do research full time, currently. So put me in that framing. [laughs]

John Bellone 1:08:43

Excellent. So question number one, if you can improve one thing about the field of neuropsychology, what would it be?

Raeanne Moore 1:08:48

You know, I think it's happening slowly, but kind of what we've been talking about. I think that integrating more technology into what we already do is going to be important. I think one way to address this is some of the things we've been talking about. Using these science models to scale up some of this tech more quickly so that it can then be rolled into clinical practice. Integration with electronic medical records are ways neuropsychologists can monitor their patients outside of the clinic. Also having people monitor ourselves and identify insights they see in themselves and then shift the relationship between the neuropsychologist and a patient from being hierarchical one directional to more of a collaborative relationship. I also think we're at a point where we are making the fundamental shift, as we talked about, from comparing individuals to others versus comparing individuals to themselves. Ryan, you were asking about this and we talked about this a little bit ago, but this is

a very precision medicine-y framework. I think that would benefit from shifting a little bit to that approach, and we're positioned at this time to do that.

Ryan Van Patten 1:10:15

And, to wrap up, what is one bit of advice you wish someone told you when you were training, or that somebody did tell you that really made a difference? So we're looking for an actionable step that trainees can take that they might not have thought of to improve their training and performance.

Raeanne Moore 1:10:30

I've had so many wonderful mentors over the years and I continue to have great mentors. It's hard to pick one tidbit of advice. But I think, along the theme of what we've been talking about, my dissertation advisor actually taught me that it's okay to change a neuropsych test. Of course we need to validate it and establish psychometric properties, but we don't have to use the same tools as our predecessors just because they have good psychometric properties or that's the test we've always used. Think of the Boston naming test and some of those images - how relevant is that to today? The message I'm trying to convey is letting our trainees know it's okay to innovate. We can do this and continue to be the experts in this field and still move forward. There's a lot we can learn from other disciplines. I really encourage all of my trainees to engage with as many interdisciplinary teams as they can. Especially our colleagues in engineering and anthropology, computer science, behavioral health, but really take a more interdisciplinary framework to thinking about their career. There's lots of different options available than I was aware of when I was in school and a trainee. I think also a silver lining, if we could call it a silver lining, of our current COVID crisis is there's this sudden and immediate fast tracking for remote assessments. So right now really is a boon for digital health and it provides an opportunity for us to improve our tools we use and really reach and help more people than we were able to in the past.

Ryan Van Patten 1:12:27

I hope that has been salient for everyone listening to just how this topic EMA, mobile cognitive testing, different digital techniques to collect data, it's very relevant. It would have been relevant a few months ago, but especially now. Maybe young researchers who are looking for a field to go into within psychology or neuropsychology might seriously consider this area because like, you say, it's going to take off even more as we move forward. This conversation has been great, Raeanne. Thank you so much for your time. I know I've really enjoyed it.

John Bellone 1:13:04
Yeah, same here. It's a really cool new world, potentially, that we could get into as neuropsychologists.

Raeanne Moore 1:13:10
Oh, thanks for having me. It's been fun. You guys are like mini celebrities among all the grad students. [laughs]

Ryan Van Patten 1:13:21
[laughs]

John Bellone 1:13:21
Not the coolest celebrities, I guess. [laughs]

Raeanne Moore 1:13:24
I told them the other day I was going to do this today and my grad student was like, "Whoa!" [laughs] Sorry we weren't able to get together in person, but we're all practicing our social distancing. [laughs]

Ryan Van Patten 1:13:37
Hopefully we're all happy in our homes. [laughs]

John Bellone 1:13:40
We're moving around sufficiently, at least within our homes. [laughs]

Raeanne Moore 1:13:44
Continue to have these Zoom meetings. [laughs]

Ryan Van Patten 1:13:49
Thanks, Raeanne.

John Bellone 1:13:49
We'll have you for a Zoom happy hour soon.

Raeanne Moore 1:13:52
All right, look forward to it.

John Bellone 1:13:53
Okay, take care.

🔊 **Transition Music** 1:13:54

John Bellone 1:13:58
Well, that's it for a conversation with Raeanne. Just a quick reminder to everybody, if you haven't yet left us a rating please just take a minute and go to your Apple podcasts app or wherever you're listening to this on and just leave us a rating and review. It really helps us tremendously. We hope you'll join us next time as we continue to navigate the brain and behavior.

🔊 **Exit Music** 1:14:20

John Bellone 1:14:43
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Ryan Van Patten 1:14:55
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