TRANSCRIPT

Sarah Smith (SS):

Hello, everyone. Welcome to Gaming and Your Brain, part of The Live Better Longer series from the American Federation for Aging Research and Prevention Magazine. I'm Sarah Smith, the editor-in-chief of Prevention, where I oversee our monthly magazine or site and other books, DVDs, events, things you see the Prevention name on. I'll be talking to our brilliant scientists today and taking your questions from them too. If you haven't joined us before for a Live Better Longer webinar, welcome, and to everyone else, we are glad to have you back. We are having fascinating conversations with leading experts so that we can share not just the latest research around health and aging, but understand how to apply it to our lives. AFAR is a leader in supporting aging research. The work they're committed to is literally changing people's lives. Prevention has a long history of bringing innovative ideas to a wide audience, so I'm thrilled that we're working together and I'm even more thrilled to be talking today to Adam Gazzaley of Neuroscape and USCF and Craig Stark of UC Irvine.

So doctors, by way of introduction of yourselves and what you do, would you each tell us what brought you to the field that you're in? And perhaps also tell us if you have a favorite game of any kind? Dr. Stark, do you want to start us off?

Craig Stark (CS):

Sure. I got started in this, pretty got hooked by an undergraduate course taught by Dan Schacter, and he was laying out the phenomenon of amnesia. This is when people have damage to a specific spot in their brain, the hippocampus and related structures, there's actually a beautiful artistic rendering of a hippocampus by an artist Greg Dunn, and these people are locked and frozen in time in many ways, but not always. They can't learn new facts and events, but everything else is just fine. So if you've ever seen the movie Memento or even Dory and Finding Nemo is a great amnesiac patient. So for me, it was, how is the brain set up so that this happens? And that really hooked me to get into it. What hooks me games wise,

I tend to favor the big open world post-apocalyptic fallout type games or something like that. Right now I'm doing Red Dead Redemption 2, but it's the big open world exploration type games.

SS:

Cool. That sounds great. Thank you. Dr. Gazzaley, how about you? How'd you get into this and what do you play?

Adam Gazzaley (AG):

Yeah. My interest really stemmed out of frustration, to tell you the truth. I had been studying attention and aging for many years, and it's not a happy story, let's say that. We know that our attention abilities decline as we get older, the evidence supports it, most of us feel it. Older here means older than mid 20s. I was studying that for quite a while, and the data's quite convincing and it's certainly interesting, but it's not a curious story. I wanted to flip that story around and determine how we can use neuroscience inspired invention to try to improve attention in older adults. I thought that an interesting idea was to create video games. There's a lot of evidence, and we're going to talk about it in the consumer space, and Craig has generated some of that where video games could have benefits on cognitive abilities in older adults. I had this idea that maybe starting from scratch, we could build a video game that could improve attention.

AG:

That started off a decade of work on creating video games as tools to improve memory, attention, perception, and other aspects of cognition. I like games that cover the full gamut. The game that I would say is my favorite game of all time was a game called Portal 2. If you played it, it's pretty remarkable and clever. It's like a puzzle game, but it's 3D puzzle game, and Portal 2 has this interesting ability to play it as two players. So, my wife and I played it and you could see each other, and when you play it in cooperative mode, it literally means cooperative, so you cannot solve the puzzles unless you work together. It was really a lot of fun for us to play it. It took months to play it. Yeah. That was, I'd say my favorite.

SS:

Wow. That's really cool. How well do you work together really?

AG:

Yeah. It pushes you.

SS:

Yeah. I think what worries so many of us, and the reason we're looking at ways to sharpen our brains and curious about games is about memories and losing our memories. I think we should start there before we dive even more into the gaming aspect of it. Dr. Stark, could you give us an overview of what's happening in the brain as we age past 21 and beyond, and as it connects to our ability to remember things, where you left your keys, but even things from longer past?

CS:

Yes. One of the things that we have to really keep in mind is that there are changes going on in, we call it typical aging outside of any of the kinds of dementia. This is one of the key backdrops, that we know that just because you're seeing some changes in your memories, some changes in your attention, your processing speed, this doesn't necessarily mean that for example, you have Alzheimer's disease. And so, that does make it more difficult for those of us studying aging and studying dementia, because it's a moving target here, but we do know that there are changes that are happening inside your brain. It's not so much that you're losing neurons in most places here, but something about the way the systems are actually doing their computations, the way they're interacting with each other, that this is changing. We see there are some key areas that are changing more than others.

I study the hippocampus a lot and its related structures do change with typical aging, but when we're talking about a memory task, the hippocampus is critically involved in that. But so are a lot of other regions, the prefrontal cortex and the tension and all of these kinds of things are really interacting to give us the kinds of things that we have as memory in everyday kinds of events. And those other regions, prefrontal cortex is also showing all sorts of disruptions in everything as we age. So, the system is changing, it's a moving target, but it's not necessarily the case that, oh, you're losing millions and millions of neurons or something like this throughout there, or that this is really being triggered by buildup of amyloid and plaque and everything in your brain. But there are disruptions in the communication and how well each portion of the brain is actually processing information, and that's one of the great mysteries for us to be unraveling as scientists.

SS:

Right. Fascinating. Yeah. That's interesting that we're not talking about dementia necessarily. We're talking about the changes in the brain. Dr. Gazzaley, you mentioned you worked with attention before, that connection between memory and attention, focus and retaining memories.

AG:

Yeah. It's sometimes easier to think about the different functions of the brain in buckets, memory and decision-making and perception and attention, but it's not really how it works. They all interact together all the time, and they're not really separable. A perfect example of that is attention and memory, attention influences every aspect of memory and every type of memory, whether it's that immediate quick, what we call working memory or longer-term memories, attention can influence how you record memories in the first place, how you recall it later on. That's what a lot of my work focused on: many times what presents itself as a problem with memory was often related to attention issues, especially with aging. And there may be an increased susceptibility to distraction. We know that if you're not filtering out all the irrelevant information around you, then the most important things that you're trying to retain might not stick as well. We also focus on is switching attention, or what sometime is called multitasking. That also degrades our ability to remember things when we're not giving one single source of information our full focused attention. That's a very real practical way to think about memory: it takes place in the context of the other things that are going on in your world at the moment. We know that in addition to well-documented memory changes with healthy aging, there's also these attention changes that then interact with that.

SS:

That's really interesting too. Dr. Stark, can we talk about enrichment then? How does that fit in here?

CS:

Adam mentioned in his intro that his hook into the gaming was his memory research with AFAR. But my hook into the gaming really was the same — the "What can we do?"— because when I can show that, yeah, the hippocampus is changing, that's why you're losing your memory for the details or part of why you're losing their memory for the details as we age, what can we do? Well, my research has often really looked a lot toward animal models where we have so much more control and so much more precision and know a lot of the neuroscience a lot better. There was a finding in the [scientific] literature there that had been around for many, many years and well studied, around this thing called environmental enrichment, which basically comes down to, if you have animals live in a world that has, well, other animals to interact with—places to explore, novel things to then go and figure out, to look at, a richer world—than the mere act of doing this has all sorts of positive benefits for them. We can see inside the hippocampus that there are new born neurons as an adult, it's called adult neurogenesis that we think are involved in memory. They bring in neurotrophic factors, growth factors, all sorts of things happen inside of the hippocampus that make it work better, and this happens not only in young animals, but in older animals as well, and their memory gets better. So the idea was, could we take this environmental enrichment thing and apply it to humans?

We also know, as we get older', our social circle tends to get smaller and smaller for one reason or another. Maybe it's mobility issues, maybe it's cognitive issues, maybe it's social kinds of issues and changes in your social circle. Often, it gets the case that we don't get out and do as much. We don't engage with things as much, and so we may be giving ourselves a less and less rich world as we age. Is that actually maybe making the problem even worse as a snowball feedback loop kind of thing? Could we actually take people and do an environmental enrichment manipulation, and maybe even restore some of their memory ability? And that was then that hook of trying to see, can we actually use in this case video games to try to actually get at a way to actually turn this around and make our memories better?

SS:

That's so interesting to me because I'm hearing multitasking is not helping me, but I also need to have many happening, interesting things in my world, and how multitasking and enrichment is not the same thing. Whereas I think sometimes we think, I've got my phone and my TV and my whatever, I'm enriched, but not really. That's super interesting. Speaking of those things, Dr. Gazzaley, where does technology fit into all of this? Because we do hear all the time that all these screens are bad. But I think you and Dr. Stark both probably have a more complex view of where screens can fit into our lives. Can you separate that for us, the good and the bad there?

AG:

I think it's always more nuanced than it's often packaged. I would say that anything that has the power to do bad can do good, and the sword slices both ways across everything. I mean, even running can be great for your cardiovascular health and could destroy your knees. I mean, everything can be done in excess, or can be done inappropriately, and can because harm, even though it might be really healthy for you and technology and video games in particular are a perfect example of that. They can be used in a way that's quite destructive that fragments your attention, that diminishes your ability to interact deeply with others, that actually decreases your productivity, that impacts your sleep. There's a long list of ways that technology can be detrimental, but it also has, I think, an incredible promise obviously in terms of productivity and communication, and in this domain that we've been talking about as well. That's what attracted me to this research: the double sided message here, even with video games.

I mean, a lot of people look at video games as like they're bad. And there's complexities there. There's very violent video games, and the jury is still out on a lot of it, and then the success of use of video games. So I see both sides, but I was really encouraged by very early work by researchers like Sean Green work showing benefits of consumer video games on cognition, and felt that fundamentally, it makes sense. From a neuroscience point of view, challenge and enrichment is going to activate the brain in a very selective way. And if you engage in a deeply, because our brains have this phenomenal plasticity that they can modify themselves at pretty much every level that they operate, that you could have benefit from these. That's like the flip side of the story, that you can engage in technology in a healthier way, both consumer technology and also specialized technology that's designed to actually lead to benefits.

SS:

Okay. Great. Let's talk more about that, your work, both of you do with games and the brain. Actually, Dr. Gazzaley, could you tell us a little bit more about what we mean when we talk about gaming? Are we talking mostly about video games, just crossword puzzles fall under this category? What are we talking about today?

AG:

I mean, games are a gigantic category. So, the first thing is to realize that even the question of video games, good or bad, is not really a relevant question. It's like saying, are drugs good or bad? It's like some drugs will save your life and other drugs will kill you instantly. Video games are really broad, and even if you go bigger than games, which don't require digital medium or even bigger, games could be open-ended games. These are sometimes called sandbox games like Minecraft, where you explore and

the goals are less well-defined and more creative. They can be massive multiplayer games where you have a headset on, and you're talking with people all around the world simultaneously, very fast paced. It could be strategy games, very slow moving games, and they all could have different benefits or different challenges to the individual because they are such different types of experiences and interactivity.

We often talk about video games in this context of games to help people's attention or memory, largely because they can be delivered in a very precise way. It doesn't mean that real-world games are not beneficial. Matter of fact, they have lots of benefits that video games may not, like being out in nature and having lots of other people around you and face-to-face contact. Real world games are amazing, but I and others, especially in the scientific community, I would say, have really focused in on video games because they're the type of things that can be controlled very precisely. It appeals to the scientist in that you can manipulate the reward and the stimuli and the challenges in very precise ways.

One last thing I'd say is that games and software that creates experiences can be used to create something that we call a closed loop system, meaning that they're responsive to the individual's own state at the time, their performance, it could be their mood. You could collect data from a player, which we do this all the time, and then use that data in real time to change the rewards and the challenges in the game. That creates a very personalized experience where it's like hard enough to push you, but not so hard that you give up and not so easy that you're bored. That is a much more challenging thing to do in real world games where you don't have that feedback loop.

SS:

Right. Dr. Stark, would you describe the work that you're doing in your lab?

CS:

Sure. It's always fun to be chatting with Adam on this because it's such a complimentary approach. I said that I'd gotten into this from the hook of that environmental enrichment. And so, we decided early on that let's try using commercial office shelf video games, and we decided that for a few reasons, one is that we could have these incredibly rich worlds that we have professional game designers and artists going and creating. They're coming up with all of these things that are engaging. People pay good money to go and do this on their own, and so being able to actually get them to do this, it's a lot easier than doing the challenging thing that Adam did of then trying to go and make your own games and have all that control. So we lose some of the control, but we gain then this incredible richness for free and the accessibility. We tried to see, could we use commercial games, which anybody can just go out and get?

And it doesn't matter where in the world you are: you could be in an Arctic ice research station or whatever. In fact, we're actually advocating to NASA that they're doing this on Mars missions. You can be literally anywhere, I guess not even in this world, and be able to be playing these kinds of things, and if it's going to have a positive effect, cool. So, the idea initial idea came about by a postdoctoral researcher in my lab, Dane Clemens who said, "Let's see if we could take a commercial off the shelf video game, take non-gamers and use this to actually improve their memory." In our first example, we had college undergraduates play Super Mario 3D World for a half hour a day for two weeks. We compared it to the not playing at all, and then also to a very simple but engaging addicting game, but one that doesn't have this richness and exploration and all of this novel discovery thing, Angry Birds.

We found out that, yeah, it turns out that playing for a half hour a day for two weeks actually improved your memory. And the more you explore it inside of Super Mario 3D World, the better your memory got. So we then took that and we said, okay, we have something here, what is it about the game? We ran a whole study in Minecraft where we changed around the parameters, are we having you explore, are we having you to learn to build new things? If so, how complex is that, and how engaged are you? Again, it

was the amount that you're engaging in doing new things, whether it's exploring the world, whether it's learning how to build new stuff, that improved your memory. We took it into older adults and we replicated this Super Mario thing in folks in their 70s and 80. Sure enough again, doing that improved their memory. Interestingly, playing a little bit of Angry Birds improved their memory as well.

So we wondered, what if you're a 75, 80 years old, and show up to your house with a big flat screen TV and you're learning how to play video games! That's a novel enriching experience that you're having. So, we did that with them and it worked. We did the Minecraft one just now in people in their 40s, and again, it works. And we took it outside of video games; in fact, outside, we made a little scavenger hunt for older adults to play as they would go to a park. Where's this, go find this, go find this, go find this:] they explore around the park, and then they learn where these little spots are. And after they've done that for a week, and they've learned a bunch of new locations, we can do another park, another park, another park. And again, each time do this by giving them something novel and enriching, engaging kind of experience, their memory gets better and gets better by the same amount each time.

So all of this kind of thing now in five studies, we've been able to show that if you have this enriching experience, which can be as simple as sit down in front of a computer or a console and have a game, you may not be able to actually go and walk around that park. Maybe you don't have good parks, maybe you have limited mobility or you don't have access, but it's pretty darn easy to actually have access to these games. So to us, then this was a great way of just being able to get that access and everything out there, to if it works. And five out of five times it has.

SS:

Well, I think my son is going to be really happy to hear that I learned this today, because he's going to want to play even more Minecraft.

CS:

The nice thing for the parents is each of our things has been about a half hour a day for two to four weeks, then all of a sudden, the kids start focusing more at that point.

SS:

That's true. Well actually, do the games have that have a long-term benefit?

CS:

What we've seen so far in a number of the studies we've done is a wash out. Where we follow them up about a month or so later, and both in one and two month follow-ups, we've seen that there still is an effect there. One of the great things for me as a researcher that I really do want to be able to track down, because at some point, this has to return back. There has to be something in this, because otherwise, look, all of the enrichment you've had, we would all be phenomenal at every single memory experiment ever. That can't be the case. But biologically, there are reasons to think why they should have long time constants to them. We've not been able to see it go all the way back down yet, but that's definitely something that want to be following up on.

SS:

Dr. Gazzaley, can you tell us about the work you're doing that's not with games like Minecraft? Can you tell us about NeuroRacer and what your research is showing us?

AG:

Yeah. NeuroRacer was our first game. We have almost a dozen now at Neuroscape, which was our center at UCF that we've built in-house and tested on multiple populations. But I'd say older adults are the main target of most of our first research studies. But NeuroRacer was our first game, was from 2009 as an idea, and was a game that we developed with friends from LucasArts. We did have some pro game developers help us build it. The idea was to challenge, in this case, older adults with a very high level of cognitive control demands and tasks. What that means is that there's a lot of distractions and a lot of need to move attention back and forth into ... very rapidly respond to only certain things and ignore others, so very demanding. It was adaptive, so it was pushing the player right to the edge of their ability.

We found that our adults got better at it, as we often see, but then in order to show that the benefit leads to something outside of the game, you do test before and after, we call it pre and post tests, and you determine, did that change happen significantly and how to compare to the change in another group. In our study, we did a different version of NeuroRacer that didn't have quite the same level of interference of challenge between two tasks. And sure enough, we showed that we able to improve both attention abilities, as well as memory, very short-term memory, we call working memory.

We published that in a journal called Nature in 2013. It's a really exciting thing for a scientist, and it was a really important moment for us because it was our first step into this process, which we've now been engaged in, in a decade of starting with an idea of a certain type of interaction that we think would have a benefit on cognition, building the game that takes a couple years for every game that we build and then doing these deep dive research studies, just to determine if there's a signal there. So, we don't have the numbers and the diversity to say, this is a prescription, you should go out and buy this right now. It's just to say, something's here, there's a clue here that this is something that could be meaningful and sustainable, and now it needs further research. Our games have been very broad in the types of interactivity.

NeuroRacer is a fast paced, maybe called an action game, but we've also built games and some of them are barely games, like a meditation based game that we just recently had a series of papers on. That game takes place with your eyes closed focusing on your breath, but it still has rewards and adaptivity like our other closed loop games. Lastly, we built games in virtual reality, and recently had a publication on that very much inspired by Craig's work that he already described to you about enriched environments and 2D games and exploration games. We wanted to take it even further and say, let's say you were in a real immersive 3D environment and moving your legs and searching and navigating. And so, that was the inspiration for that, and we just recently published that paper. So, our games are pretty broad in the type of designs that we undertake.

SS:

Interesting. Can you tell us about who you're studying with this? Are there challenges particularly for older adults with these, are they playing those games and seeing the benefits?

AG:

Yeah. Most of our studies are on healthy older adults, and we randomly define that from 55. It used to be 60, now we go 55 to 90 year olds, and they love it for the most part. They really engaged in the studies, they're really excited about it. It's what I think is essentially a myth out there that older adults don't like technology or video games. We see the opposite all the time, and they enjoy them. It's like all human variability, some people like certain games better than other ones. But we also use the same games and study their benefits on children, adolescents, healthy young adults and clinical populations (multiple sclerosis, depression, autism, ADHD.) We've done studies in all those populations with games. The really beneficial thing about the game being closed loop, that term I used before, is that if you are slower or

struggling in some way, the game knows that. You don't have to enter that information, the game is looking at your performance in real time, and then we'll just adjust the challenge appropriately for you.

That's really, I think the benefit that we have of building games from scratch is that not all games have that type of adaptability to give you a very customized experience at your ability without being too hard or too easy. And that has allowed us to move rapidly across populations.

CS:

Yeah. That really tailoring the game. Obviously, when you have the control, you can build that in. There are a number of games that ... For example, there's a reason why I picked Super Mario 3D World, and it comes down to things like, well, it's meant for little kids to be able to play. And so even with that, in some of the Super Mario series for example, if the game senses that you can't get over that obstacle, or you seem to be lost or too much time has gone so that you're not really on track, oh, wait a minute, we're going to start showing the path that you should be taking, or you've tried jumping over this here four or five times, it hasn't worked, okay, do you want to auto go across, to again, try to get it so that it keeps the frustration down. And so, yeah, we end up using a lot of, in our older population, we end up using a lot of games that were originally designed for younger populations.

And some of these, like Minecraft, I mean, folks will have their young kids playing, but my oldest son is an avid gamer, he's getting ready to go off to college and everything, and he's still doing a bunch of things in Minecraft. I said, "Really? I mean, come on, you're still?" But he's like, "Oh, yeah." And then he shows me these incredible worlds and machines that he's building. People have built entire word processors inside of the game using the complex logic gates and everything you can have inside there. So, it's that ability to have something that won't be frustrating, that is novel and engaging, that's pushing in some of these kinds of ways that can adapt and everything to them, or they can adapt to it. In fact, our study with Minecraft showed if you just give them an empty box, young adults an empty box with tons of stuff and say, go do whatever you want, turns out that didn't actually help their memory.

If you keep pushing them, you say, okay, you learned how to build this. Now, how about this? How about this? How about that? We push them to do tougher and tougher things, oh, that helped. So this thing again, where it's that notion of adapting, notion of being able to keep pushing you and all that kind of thing, yeah, in both of our sets of research, that seems to then be a key.

SS:

What opinion do you both have then on the various brain training apps and games that we all get marketed to us that are supposed to help with this? It's not Minecraft, it's something else.

CS:

You want to take that one, Adam? Take it first?

AG:

Sure. It's a slippery slope. I would say that there's a couple things, something can be based on a good solid principle and foundational concept, like that the brain is plastic. All that is true, but it doesn't mean that the instantiation of that is going to lead to the outcomes that you want. And so, it's not enough to base something on a scientific principle. I mean, it should start there, we all can agree on that, but in and of itself is not enough. You then have to build it with all the different insights that you can gather from multiple fields really or find something that fits that goal, and then do the research and determine what benefits it has. And so, sometimes there could be products on the market that may be inspired by all the right reasons, but may not have the level of data that gives security that something meaningful is happening from the engagement.

AG:

The other side of it is that not all types of engagement are going to lead to the same type of outcomes, and I would say that for maybe things that fall in the brain game category, if they're not really fun and deeply immersive and engaging, and you don't really apply yourself, it is unlikely to lead to the same changes. I mean, just think about the physical fitness example. If you go through the motions because you're a paid research participant, but you're not really working out, you're not really engaged, it's not really absorbing you, you're not really training for that marathon, you're not going to have the outcomes. Our body has this plasticity, but it also has this property of homeostasis. It wants to stay stable in a lot of ways too, so you really have to apply pressure to change things. I don't want to lump everything into a basket because it's not fair because there are a lot of really good studies and research out there that fall into that domain of cognitive training that might not be a video game, but in general, those are the issues. Is the interactivity to such a degree and targeted enough and adaptive enough and fun enough that it's really going to lead to deep and sustained engagement over time? And then, has the research been done to show what are the benefits?

SS:

Great. Thank you. Craig, do you have anything to add to that, or we covered it?

CS:

That really covered the theme. I think the only thing I really had are the bits about, is there evidence that it transfers? I mean, you're going to get better at that game, great, practice makes perfect. Do you get better on anything else? Have they been able to show that kind of thing? And some have, but that should be one of the things that you're looking at in all of this. And then finally, as a consumer looking at this and looking at your choices, what claims are they making? You won't find us saying things like, oh, this will cure Alzheimer's disease. No, we don't have any evidence. It would be great if it did, but I don't have any evidence that it does any of that. And realize that to get that kind of evidence, it's going to be a long, long, hard road to get that evidence. We have to start with the science. We have to do all the initial studies, and each one of these things takes time and time and time. I mean, like the classic snake oil, here's this one thing and it's going to do this…[but then people assume] "oh, you have gout oil, it'll do that, or you got headaches, well, it'll do that, well it'll do that" …probably not. I would have more credence for ones who actually claim to have more modest kinds of effects.

SS:

Great. Good reminder. Thank you. We're getting a lot of good questions coming in, so I'm just going to ask you both two more high level questions, and then we're going to go to our audience questions, which are really terrific. First, what do you see coming down the road for this area of research? What are you excited about?

CS:

I should probably let Adam give this answer because it's what he does, trying to really come up with customized kinds of software and really getting at that optimization. Because to me, it's figuring out what are the things that really matter? What's the dosing, what's the kind, what's all of these sorts of things. We have some good guesses on, we have some hypotheses on, but we need the really good, hard data on it. And in what areas does it actually work? I think that one of the great things now is that there is enough evidence from some number of labs that have been working on this to say that, yeah, these have effects. I hope that this now blows up into a really, really large whole set of projects being run by labs across the world to really try to hammer this out and have a lot of researchers look at it. It works. It has changes. Why/how should we best use it? That's now to me, the next big thing that I want to try to have, not just the handful of labs working on it, but have a bunch of labs working on it.

SS:

Interesting. Dr. Gazzaley, what do you see coming?

AG:

Yeah. I mean, all those things, of course, that's the next frontier. Maybe just to add a little onto it, we've started on this path that I described of the closed loop video game. How do we take data about the individual and use it to customize, personalize that experience? There's a lot further we can go, and we want to get there. So on one side of it, very frequently, we use pretty simple data like how fast you are, how accurate you are, other performance measures. We're now really devoted to recording both neural activity, as well as physiological data, looking at different aspects of your nervous system, your autonomic nervous system, your mood, your level of stress, and having this data collected and interpreted in real time so that it could guide elements of game play. That is a very thorny challenge. It has not just the neuroscience aspects of it to know what are meaningful signals or the biology side of it, but also the technology side, what sensors are we using? There's signal processing, how do you interpret these signals, including things like machine learning and artificial intelligence?

All of those tools should be part of this system, and our goal is to accomplish that. Imagine you could understand a person state in the moment, what their level of attention was, whether it was externally or internally directed, if they were feeling stressed, if that's just as positive or negative. I think that that can be accessible to us, but there's a lot of work that needs to be done. But all of this could be signals into the game play. And then on the other side, in terms of the gameplay itself, I'm very interested in multi-sensory immersive environments. So, we've taken this leap into virtual reality where someone wears a headset and they have headphones on, and they move their legs, there's no doubt that's more virtual than playing on a tablet, but we could go further. So, how about if you see, hear, smell and feel things? We think that if we could create more immersive environments, the power of these experiences to lead to change will be greater. That's a hypothesis, but it's an interesting one.

And so, both of those goals are really technology goals in addition to neuroscience ones, and that's what Neuroscape is made to do now, is to really push the limits on both the technology and the neuroscience side. Those are some of the directions that we're heading in.

SS:

That's very exciting. It sounds almost futuristic, but not quite and what already exists.

AG:

That's my happiest spot.

SS:

Before we turn to the audience questions, can you each leave us with one a final message and then we'll take their questions?

CS:

If I had to give a prescription, something to take home from it, it's do something new. Whatever you're maybe even doing some sort of crosswords or whatever kind of thing, and trying to stay mentally fit this way, do something new that can get you engaged, and that can be, whether that's a game, whether that's exploring some new park, hiking in a new area, whatever it is, feed your brain novel information, novel complex information, give it that kind of diet, continually expose yourself to that kind of thing. And if you're going to try to do something to help yourself out there, that would be the quick take.

SS:

Great advice. Dr. Gazzaley?

AG:

Yes. I echo that advice strongly. I mean, maybe just to add a little flavor to the same advice is that while we work in this new field of technology, as medicine is often how I think about it, there's a lot to do just in the real world that we're not fully taking advantage of. And so, none of the things here are meant to replace real world engagement, so I always emphasize nature exposure. There's nothing really more important, I think, than being out in nature and being physical in the world around you as best as you can, depending on where you live. But even going for walks outside and being in trees, I think that's really important. And then of course, not being isolated. I emphasize that one as well. As we know with aging, there comes the challenges within, but also the challenges without, and if your social network, your real-world social network has degraded such that you're now more isolated, that's going to feed into all of these challenges that you're feeling with your brain and your attention and your memory. So being with people and being in nature, I will put that out there.

SS:

Great. Thank you. All right. I'm going to turn to some of these terrific questions that we're getting, we'll get to as many of them as we can. I'm going to put together two that I think go a little bit hand in hand. One is, is there a cumulative effect to playing video games earlier in life that can delay normal aging changes? And then slight flip side to that is you've studied young adults and a variety of people, is there any research on video games helping those who already have mild cognitive impairment? Is there a cumulative effect to prevent it? And then what about when you have the impairment? Can this help?

CS:

I mean, they're great questions, the challenge with the cumulative thing to then prevent age related cognitive decline is that we have yet to make one critical intervention, time machine. The ability to then go and do that kind of study and say, okay, we're going to get these people, we're going to have them game when they're teenagers, and then we're going to follow them up when they're 80, time gets to be a little bit of a problem with that study, we think maybe. And then, this is also why we're doing some things in the middle age right now to try to see interventions there, et cetera, et cetera. And so the answer is that it's going to be a big good idea, but we can't really have that solid answer just yet. In terms of the older adults and everything. Yeah, we look, as we both talked about, we start to see that there are declines even starting in your 20s on a number of things.

CS:

And we can see that these sorts of things are alleviated and boosted up by this. In fact, the studies that we've had on the memory test of the hippocampus based memory test that we use, it's about 15 to 20 years' worth of cross-sectionally measured cognitive decline that it's fixing. We've worked with some folks who are having some early stages of memory impairments on it. Adam's worked in a whole bunch of different populations, and it does seem to be improving performance. Now, is that actually altering the course of the disease or something like that, that's another big hurdle to try to get over, but sometimes it really is just, can you make the cognition better for a while? It does seem as if in a lot of those cases, that the answer is yeah.

SS:

Great. Thank you.

AG:

I agree with all that, I think that there's still a lot of more research to be done. That's the basic underlying answers that there's a lot to be optimistic about, but a lot of work to be done. I was also reflecting on that first question of the first video games really came out probably when we were younger.

CS:

Exactly. We're the first generation that this could almost be done yet. By the way, it was like space invaders and asteroids and all that.

AG:

Yeah. Exactly. Exactly. So yeah, time will tell, but I would say if you look at other adjoining fields like music experience or bilingual exposure in young people, the data does exist that it seems to benefit them later in life. So, it's a leap obviously, it's not a research study, but if you make the leap that those type of enriched environments or enriched exposures have benefits on the aging brain, it's certainly a reasonable hypothesis that it met.

CS:

It's a great hypothesis, good to back it up.

AG:

That's a great analysis. Yeah.

CS:

Right.

SS:

Cool thought, yeah.

CS:

We're both scientists, so yeah.

AG:

Exactly.

SS:

Still, I think it's a cool idea. All right. Can you describe how you work with older adults in your research process, how is attention and working memory tested, and after what duration of playing games, and then a follow up of how could someone volunteer for research in this area? I love hearing that question.

AG:

Yeah. When you do a research, this is the basic design of a research study, it sounds like that's what the question is. We recruit people that fit into a certain category that we're studying, healthy, older adults, children, people with mild cognitive impairment. And depending on the study, they may be put into different groups. This is usually done in a blinded way, there's randomization involved, these are the methodologies that allow us to determine if our results are meaningful, in the field, not just our field, all scientific fields. We're still developing a methodology, but there is an approach that is felt to be the most rigorous in terms of reaching conclusions. And then our participants would come in and they'll do a number of tests. So if it's working memory, they might do a test where they hold information in mind for very short periods of time, they may be pictures or numbers or colors or angles, if it's long-term memory, they'll see certain things, and then later, they'll get tested on it to see how well it stuck.

That could all be done beforehand, and may even be done on a day beforehand, then you would engage in the intervention, whatever it may be. It could be a drug trial, or it could be a video game treatment. And then you come back and do the post-test and we see what changes. So, it really depends on the study design. What we're trying to do is think, given this type of challenge from a game of this sort, and our understanding of neuroscience and the systems involved, what might be the improvement that we could

document? And also, what are some things that we think wouldn't change to show that it's real, like it's not just everything's getting better? Those are how we select our outcome measures. And for the most part, and Craig should obviously answer this for his own studies, we've been fairly constrained geographically.

For the most part, up until very soon in the future, we have been with a design that if you are in San Francisco, could have access to our laboratories, then you would come in and you could be involved, because we also often do brain imaging and other parts that we need you to be physically present. And so that is unfortunate because it means that most of our study participants have been local to the Bay Area. We're just getting ready now to launch large distributed mobile studies where people can download our games at home and do the outcome measures. Now, obviously it's not brain imaging, but you could do the tests before the pre and the post tests at home. It's taken us years to build a platform to be able to do mobile randomized controlled trials like this, but we've completed, it's called Nexus. It's been a real challenge, but a real exciting tool that we now have.

This year, we'll start launching big giant studies where you don't have to be near UCF to participate. And if you go on the Neuroscape site, there's a mailing list, and that list is how we'll announce when these studies are launching.

SS:

Great. Thank you. Dr. Stark, what about your work?

CS:

Yeah. If there is a silver lining to a global pandemic and having to shut the labs down and not be able to come face to face with somebody for over a year, the silver lining has been in really being able to transition so much of this stuff to being able to work online. So, all of our main assessments and everything, we rapidly took to being online, and then a nice thing about playing off the shelf, commercial games and everything is, well, you can ... look, people are naturally doing this inside of their own homes. So in all of our things already, maybe for example, in Minecraft, they would be logging into our internal servers, so we actually have control over the world and all of this. So, the nice thing then is it gets so that for a huge number of these things, we can actually be doing now all of it remotely.

There are still are some things, obviously, the MRI scanners, if we try to get that on somebody, there are a number of things that are limiting geographically, but right now, a whole bunch of things are wide open.

SS:

Right. Thank you. We're getting a lot of questions, people wanting to know what games they can play, especially on their phones. I mean, do you two have any specific advice in that area? I know it puts you on the spot a little bit, but I think people are just dying to know what should I be playing, especially if I don't have a console?

CS:

Yeah. From our limited slice and stuff and everything in the research here, the Candy Crushes, the Words With Friends, this kind of thing, for a little while, they may be doing something for you for a little while, but odds are you're going to need to get into that bigger, richer experience, and a lot of these can still be had on phones. There are huge, huge array and everything of games out there, or there's also just keep mixing it up. A lot of this seems to come down to really the amount of information, the amount of novelty that you're exposed to as it seems to, because you've explored a little bit of this parameter space, but nowhere near as much as one would really want to have you explore just yet. So trying to then go and find those. I mean, I'm not going to point to individual games on individual phone platforms and that sort of

thing, in part, because that hasn't been the space I've been working in. It's been more the console and PC kinds of things that I've been into.

But I've just downloaded a couple of games for my iPad and all this kind of thing that are big, fun, like immersive 3D experience, puzzle type games and this sort of thing, but each level is very different and challenging and engaging, and it has all this novelty and everything to it, but that's the thing I would be looking for more so than a simple arcade kind of thing.

SS:

Got it. Okay. Thank you. Dr. Gazzaley, you mentioned nature earlier and somebody wondered if you know of any studies on the impact of simulated nature in gaming. Do you know if that has any effect?

AG:

It's a great question. First, it's worth noting because everyone may not know this, that there is data out there on real nature and its benefits on multiple aspects of cognition and stress regulation, and mood, including different clinical populations. That data is really interesting and probably intuitive to people, but it needs to be shown, and there has been some studies out there. Some of those studies have gone on to show that the benefits of nature, especially on restoring attention is also shown with looking at nature pictures. And so, that's a little bit in this evidence to your question. It's even exposure to artificial nature like a photo of nature seems to have benefits in restoring attention after you're fatigued by a very demanding cognitive exercise. We're really interested, as I said, in simulated nature, smelling, seeing, hearing and feeling nature sounds in this very immersive way, but there is not data that I'm aware of that's really convincing yet that has shown those benefits and how close they can get to actual nature exposure. But that's the type of work that we'll be doing over the coming years.

SS:

Great. Interesting. There was interesting question about chess on your phone, but also just related to the idea of chess being about strategy. How does that fit into novelty?

CS:

Yeah. There's chess, there's learning to play a musical instrument, there's learning a new language. I have a standing informal bet with Dane Clemens in the research where I started this with as to whether learning a new language would have a similar effect. A lot of this really comes down to what truly are the mechanisms, and there's a lot that we still don't know on that. If you take something like chess or learning to play a new instrument, it's devilishly tough and is taking a lot of attention and concentration and everything to try to actually go and do this. The sheer amount of novel information you're exposed to really isn't a lot. You're trying to learn how to master this sequence of things, or know when you can apply a certain strategy, and that may be having an effect, but it may not because of just that raw amount of new stuff that you are seeing. When you go for a walk out in the woods, as you're just walking through the path there, each of these trees is its own object and they have all their spatial relations to each other and to you and to the path, and it's changing as you move, and a bird flew by, and all of this stuff is new information that is getting automatically fed into your memory and your hippocampus, and that's stimulating it. There's a huge amount there versus I got some number of pieces on a board and it's incredibly complex. And so, I mean, I don't know the real answer to that, and as I say, one can make arguments based on the engagement and the difficulty and challenge that it should be doing something, but also arguments based on the amount of novelty that maybe it wouldn't.

SS:

Interesting. That's a really interesting take on chess. I love it. I think I'm going to take one more question and then we'll be wrapping up for the day. I saw an interesting one in here about whether you've measured quality of life changes in your attention, memory, handheld gaming interventions. And if so, what

have you learned? I think that's an interesting way to also just think about your brain and your quality of life at the same time.

AG:

I could take a swing at that one. We do that. We have surveys for all sorts of things in the real world. The challenge with that data is that it's a lot less quantitative and precise than the laboratory-based data we use. We're often left with a very strong impression of benefit, and sometimes we see it in our control group too, because as Craig was saying, even engaging in another game could make you feel engaged and really connected and very positive. So for the most part, those questions are really hard to answer, and we collect that data largely to raise hypothesis for future studies where we really target them. But my real answer here is that you need very large numbers of people to start understanding those type of changes, and that's where we're heading. With our big, large mobile trials, we think we could start having the numbers that even those softer measures, the subjective ones that are no less important, they're just hard to quantify. Then we could start having meaningful effects because we have large numbers of participants. So, it's a big open question for the entire field, and not just this field, all fields struggle with this, is that ultimate real life transfer is really elusive as far as research studies.

CS:

Yeah. Ditto. And for me, it's also then trying to then team up with researchers who really understand how to do this. So we've just turned in a large NSF grant with a couple of my colleagues here at UC Irvine on really trying to see, can we get out and be able to measure some of these things? Because they're devilishly difficult, and really trying to have the people who have the background, who have any real prayer of being able to get out of that in a scientifically valid way is not easy, but it is of course, then that ultimate thing that we want to be able to get at.

SS:

Right. Thank you both. Really interesting to look at the complexity of the work that you're doing especially because we all want so much to learn from what you're doing. So, I really love hearing what goes into it and where it's progressing. I think we've all really learned a lot today, so I appreciate both of you very much with bringing your expertise. Thanks to all of you for joining us on today's webinar. I hope that you will join us in two months when we have another Live Better Longer session on the power of sleep. I think we're all also desperate to get good sleep. We need our healthy brains and our healthy sleep, and it all goes together, I think, doesn't it? Again, Dr. Stark and Dr. Gazzaley, I really appreciate your time. And to all of you who joined us, please join us again. Thank you so much, and everyone, enjoy the rest of your day.

CS:

Thank you.

AG:

Thanks everyone.

– END –

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