

EPISODE FIFTY ONE OF "ARMED WITH SCIENCE: RESEARCH APPLICATIONS FOR THE MODERN MILITARY," A DEPARTMENT OF DEFENSE WEBCAST HOST: DR. JOHN OHAB GUEST: DR. RAY PEREZ, PROGRAM OFFICER, OFFICE OF NAVAL RESEARCH SUBJECT: GAME-INDUCED ENHANCEMENTS IN ADULT "FLUID INTELLIGENCE" DATE: WEDNESDAY, JANUARY 20, 2010

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(Intro music begins.)

ANNOUNCER: "Armed with Science: Research and Applications for the Modern Military" is a weekly Webcast that discusses cutting-edge science and technology and how they apply to military operations.

Each week we will interview scientists, administrators, and operators to educate and inform our listeners about the importance of science and technology to the modern military.

(Intro music ends.) DR. OHAB: Good afternoon, and welcome. You're listening Episode number 51 of "Armed with Science: Research and Applications for the Modern Military" on Wednesday, January 20th, 2010.

I am Dr. John Ohab at the Office of the Assistant Secretary of Defense for Public Affairs.

Today we're going to be talking about brains and video games, two interesting topics by themselves. But it's the synergy between these two that can impact the war fighter's ability to adapt and solve problems.

We're joined by Dr. Ray Perez. He's a program officer with the Office of Naval Research.

He's going to discuss how video games can impact the fundamental ability of adults to reason and solve problems in novel contexts, also known as adult fluid intelligence. And we'll talk about that more.

There's a growing body of research suggesting that the brain can improve cognitive function with age, and Dr. Perez will discuss how today's neuroscientific research may literally change the way we think 10 years from now.

Dr. Perez, it's a real pleasure to have you on the program. And I think just being here talking about why video games are good probably endears you to gamers around the world.

DR. PEREZ: (Laughs.) Well, thank you very much for that introduction.

DR. OHAB: Listeners, just a quick note. It seems we suddenly have a couple of different mechanisms to submit questions. If you have them, you can tweet to @armedwscience, or you can post them as a comment on our Facebook wall, Facebook.com/armedwithscience.

Now, Dr. Perez, you are a program officer at the Office of Naval Research's War Fighter Performance Department. Can you tell us about the Department and how it supports U.S. Navy personnel?

DR. PEREZ: Well, yeah. The Department consists of six science and technology departments, or codes. And we are coordinating -- (inaudible) -- Navy research to -- in our case, our code deals with the human systems.

So we're looking at things like medical issues, how we can best serve the war fighter on the battlefield if he's wounded, or she's wounded. And after they leave the battlefield, having to deal with things like TBI and post-traumatic stress syndrome, and so on.

Our training area is dealing with how we can develop training technologies and training methods to improve performance on the battlefield. This war against terrorists is a very different kind of war. It's not a set-piece war. It represents a real challenge to our war fighters on the ground, because they have to be able to adapt -- meaning they have to adjust their tactics and their strategies almost on a day-to-day basis.

The people that we're fighting are very innovative, and they're very deadly. So they will try one tactic one day; they will see how we react to it. They'll come back the next day completely different, adjust to how we've adjusted to their tactics.

Well, what does that mean for training? We have to train people to be quick on their feet, agile problem solvers, agile thinkers, and be able to counteract and develop counter tactics to these terrorist individuals on the battlefield.

DR. OHAB: Now, specifically, some of the program areas of responsibility are exploring mission-focus neuroscience and cognitive research programs like applied instructional research and second language learning.

Now, when people think of the U.S. Navy, they may not intuitively think of brain research -- maybe ships, planes, or other kinds of military hardware.

Why is the Navy specifically investing in neuroscience research?

DR. PEREZ: Well, let me talk about a concept that I use called cognitive readiness.

Now, cognitive readiness means preparing the war fighter not only in terms of his physical ability, but also in his intellectual capability -- teaching them the foundational skills like being able to, believe it or not, read, write, do mathematics.

Because those are the central skills that build upon the things like problem solving, math reasoning, learning a second language. These are all foundational skills that are needed to become a good warrior. Once you've applied the skills, then you're ready to go out and perform a mission.

Just like when we look at the term of combat readiness, usually the way that we measure combat readiness is when was -- is the equipment ready? Is it in good repair? Is it working? When was the last time it was maintained?

When was the war fighter, as a unit, out performing an exercise and how well did he do? And if he did well as a group, then he's combat-ready. We think cognitive readiness is a good term to focus on the readiness of the individual. And as I just discussed, in the war against terror it's not all about technology. It's really about human inventiveness and creativeness and being able to match wits with the enemy on the battlefield, wherever that may be, whether it's in a urban center or whether it's in a mountainous region.

These are the challenges that the modern war fighter will face, so he has to be cognitive-ready. And so we're spending a lot of time trying to train individuals to be cognitive-ready.

DR. OHAB: And the technical term for the ability for adults to reason or solve problems is this idea of fluid intelligence; or perhaps people have heard of brain plasticity.

I was wondering if you could break down each of these terms for us.

DR. PEREZ: Well, I'll start with brain -- with fluid intelligence, then go to brain plasticity.

Fluid intelligence was a intelligence first defined by Raymond Cattell. He decided -- he broke general intelligence into two categories. One he called fluid intelligence and the second he called crystallized intelligence.

Now, crystallized intelligence is a kind of intelligence you'd get from formal schooling -- reading, math, arithmetic, vocabulary -- all of those essential skills that represent formal education.

And he felt that crystallized intelligence was a byproduct of your formal education. So that meant that it was changeable over time, based on the quality of education you were exposed to.

Now, fluid intelligence is, in Cattell's view, primarily based on your inheritance, what you inherited in your genes. And it was felt to be immutable, meaning that it couldn't be changed.

So fluid intelligence is the ability to solve novel problems without prior knowledge or experience.

And the reason why we focus on fluid intelligence is because that's where we think the adaptability comes from for our war fighters on the field -- the ability to change, the ability to meet new problems, new tactics, and provide counter tactics and solve those problems, with (albeit ?) not prior knowledge.

And in the past, for the last 50 years, fluid intelligence was felt to be immutable, meaning it couldn't be changed, no matter what kinds of experiences you have.

Now, brain plasticity is a notion that -- brain plasticity was first talked about by people in developmental psychology. This was this old belief that, for example, if you didn't learn a second language by the time you were 10 or 11 years of age, you would never be able to speak like a native.

And the presumption was that the structure of the brain and the organization of the brain was pretty much set in concrete by the time you were out of your teens. And that view prevailed for a long period of time.

In fact, there was also the view that once -- after the age of 20, you had all the brain cells you were ever going to have and that from then on, if you had any changes, it would be that you would be losing brain cells, and you wouldn't be increasing those. But we have discovered by looking at various kinds of experience, particularly video games, that video game players, for example, perform 10 (percent) to 20 percent higher than normal people that are non-game players, in terms of perceptual ability and cognitive ability. They can acquire objects faster; they can process visual information much faster than normal individuals.

So we were looking for -- if that's so, what is different in terms of those individuals, as opposed to normal individuals?

So what we've done is we've replicated a training program that much -- looks like the experience of the video gamers, and we get similar kinds of results. We get individuals that have increased perceptual abilities; they can (substitutize ?) up to five or seven; they can increase their short-term memory; they can focus longer than -- their field of vision is much larger than regular people.

And this is all due to training on their video games.

DR. OHAB: Now, what kind of tangible impact would this have on the sailor or a Marine in the field, actually?

DR. PEREZ: Well, the perceptual abilities is if you're in the command-and-control unit and you're looking at a screen, you're looking at -- your task is usually looking at objects, visual objects on that screen.

From your radar set you have to acquire certain target areas, determine friend from foe. You have to discriminate among a number of different objects. If you have increased perceptual processing skills, you're going to be able to do that job better than someone who doesn't. So that's immediately something.

On the battlefield, your field of view is larger. Your reaction time is faster, so that means that you're going to be able to perform better than your adversaries.

DR. OHAB: So then video games can actually teach or induce brain plasticity, fluid intelligence, and some degree of adaptability?

DR. PEREZ: Absolutely. And what we're now in the phase of is looking at what're the underlying neural mechanisms that are responsible for these changes in behavior and in abilities.

And if we're using various kinds of neural imaging techniques like fMRI, that identifies different areas of the brain that show activity when you're performing certain tasks, we can even begin to look at what area of the brain is active during the processing of video information, and so on.

DR. OHAB: And who's actually developing the games that you use in these kinds of studies? DR. PEREZ: Well, the games that we've been using now are actually commercial games. And these are for these perceptual abilities and cognitive skills.

For example, the experiments that we've seen with increasing fluid intelligence, it's a game called "Rise of Nations" that's often played by many kids. It's a strategic game. We think it works because it increases short-term memory. Anyway, that's the hypothesis behind it.

DR. OHAB: Now, how do they achieve these effects from a neuroanatomical or a neurophysiological perspective, actually?

DR. PEREZ: I'm sorry, I didn't hear that. Again?

DR. OHAB: How do these games achieve these effects in learning, from a neuroanatomical or neurophysiological perspective?

DR. PEREZ: Well, we don't really know what occurs at the neural level in terms of brain plasticity, but there's a number of different hypotheses.

One of them is that the neural networks that are responsible for these behaviors have increased. There's increased vascularization around them. There are -- actually, the networks become much more pronounced.

In fact, they're -- we have seen where they -- in fact there's a kind of a synchrony. They're more in synch with other networks, and they become much more efficient.

In fact, there was a study done by Janinus (ph) and Jaegy (ph) at the University of Michigan that demonstrated that as people became better problem solvers, initially their activation levels in the frontal cortex increased. But once they began to solve the problems, their activation levels fell.

The explanation for this observation was that they were becoming more efficient in using those neural networks when they had solved the problem, as opposed to when they're still trying to figure out what the solution was.

DR. OHAB: Now, is there any indication that those who have played video games during their childhood or in their teenage years might be more primed for increases in fluid intelligence later on, or can this be picked up on the fly for people who haven't played video games in the past?

DR. PEREZ: Well, we think that -- once again, this is our speculation.

DR. OHAB: Right. DR. PEREZ: This is what we think is going on in the brain.

We think that these games increase your executive control or your ability to focus and attend to stimuli in the outside world.

DR. OHAB: And are these changes sustainable, or do they go away after a short period of time?

DR. PEREZ: Well, for the video game experiments that we've -- had conducted, the scientists that have done it have reported that they last as long as two and a half years.

DR. OHAB: Wow.

DR. PEREZ: I mean, that's pretty impressive.

The major question is that once you've increased this perceptual abilities and cognitive abilities, do they transfer to everyday tasks, and how long do they continue to influence the -- working on these everyday tasks?

DR. OHAB: Are there certain types of games or genres of games that might be more apt to be successful in this kind of endeavor?

DR. PEREZ: We don't quite know the answer to that, but we do know from our limited experience that first-person shooters tend to increase -- the action games tend to increase the perceptual abilities, because that's what you're required to do in these games.

You have to be very quick, you have to identify your enemy, you have to shoot it, you have to act very quickly. And you have to anticipate where different things are going to occur in the environment.

Now, for the fluid intelligence, we indicate that's the more strategic games, more games on -- that are looking at problem solving, and so on.

DR. OHAB: And one thing you mentioned earlier was this notion of adaptability. And obviously functioning in a fast-paced, unpredictable operational environment requires one to adapt.

Can you tell us what adaptability is and some of ONR's research efforts in that area?

DR. PEREZ: Well, we've been looking at adaptability from a number of different angles.

There are some people that look at adaptability with respect to -- with resiliency, being able to adapt to stress, to outside factors, okay? -- environment, extreme temperatures, fatigue, stress, the threat of physical harm, and so on. That's one definition.

Another definition is being able to work outside your present mindset, if you will, looking at the world and solving problems in one particular way and breaking that mindset.

Oftentimes, people talk about thinking outside the box. So in a layman's terms, thinking outside the box is a way of characterizing adaptability, meaning to think beyond what you've been taught, to go beyond your previous experience to solve new problems in maybe new and different ways.

DR. OHAB: Now, this is a science and technology pod cast. What are some of the technologies that ONR might consider or use to prepare its war fighters? Are we talking virtual worlds? Are we talking Web 2.0 tools, mobile technologies?

DR. PEREZ: Yeah, we are talking about simulations and simulators as some of our training media.

But in my area, I see things along a continuum of interactiveness and physical and cognitive fidelity. So you can go all the way from -- we're exploring using what we call mobile learning, using PDAs to deliver instruction on a small screen, just-in-time training, all the way up to virtual environments that are very much like a cave.

And you walk into a cave and you're bombarded by this totally different, artificial world where there may be intelligent avatars that

you interact with to perform a mission. Or these avatars will act as teammates, because you can't put your team together at any one point in time. So you as an individual will interact with these other avatars as a unit.

So that's what we're talking about. And we think that these technologies can be deployed anywhere. They can be deployed in the schoolhouse for teaching some very basic kinds of maintenance skills and tactics and so on, to -- (inaudible) -- to aboard ship.

DR. OHAB: Now, it sounds like from a training perspective you're really preparing sailors and Marines to prevail by closing the gap between the training and the operations.

DR. PEREZ: Well, there's this metaphor I use. Have you ever read "Ender's Game"?

DR. OHAB: I -- just recently, I finished it. Yes.

DR. PEREZ: Well, in "Ender's Game," at the end of -- at the conclusion of all his training, in all -- Ender's training, he goes into an exercise and he thinks he's performing another game, another training exercise.

And so after -- at the end of the game, he defends successfully our world against the invading aliens, and so on. And he said, well, when are we -- when are the aliens coming? And he said, it's already over, and we won.

So what we want to do is -- blur the distinction between training and operations. Sometime in the future, what we'd like to be able to do is equipment used to operate your equipment and to conduct your mission is going to be the same equipment that you train on. So that you learn to perform a task; you don't learn to operate new equipment.

DR. OHAB: Now, the body of research you've described has suggested that adults can continue to develop their brain function after the age of 20. Does that mean that the average age of a sailor or a Marine might change in the years to come?

DR. PEREZ: That's a good question. I don't know. In fact, I would argue the contrary, not because of that, but because of the cost involved.

Now we look back and we say we've gotten 20 years of someone's time. We've got our return on investment, right?

DR. OHAB: Right. DR. PEREZ: But there are technical skills that are so precious at this point in time that we may be able to get our return on investment in five to 10 years. And that those individuals, after five to 10 years, can leave the service and go and contribute to the general economy at large.

Why I say that is because the cost of humans in retirement, medical and so on, continues to increase. And can any of the services continue to keep people for 20 years? Maybe not. Even though they may be healthy, maybe cognitively function at an optimal level, we just may not be able to afford them.

And that's more of a -- that's not a scientific issue; that's really a cost and return-on-investment issue.

DR. OHAB: We have a question on Twitter from C. Conkey (ph), and he asks, with the wide deployment of Virtual Battlespace 2 in Army and Marines, is ONR looking at effectiveness of Virtual Battlespace 2 in training environments?

DR. PEREZ: Yes. One of the issues -- one of the frustrations, if you will, is that technology always leads to science. We build virtual environments, we demonstrate proof of concept, and then we stop and we say, oh, wait a minute. Do these things train anybody to do anything? And we say, well, wait a minute, let's take a look at that.

So yes, we're in the process of developing evaluation studies for training effectiveness.

DR. OHAB: Would you mind just explaining for our listeners what Virtual Battlespace is, if they don't know already?

DR. PEREZ: I wouldn't do it justice. I'm not familiar with the details of that. I can tell you generally, within virtual environments, what we're attempting to do and what the issues are.

DR. OHAB: Dr. Perez, you've done a wonderful job of pointing out and explaining the synergies between brain research and gaming. But you haven't really talked about yourself.

I was wondering if you could tell us a little bit about your training and background before you came to ONR.

DR. PEREZ: Well, I -- like most scientists, I have a varied background. I got a master's in physiological psychology, which would be called neuroscience. My Ph.D. is in cognitive psychology, so I (have a doctorate ?) there. And most of the work I do is in training and education.

But I believe that after the decade of the mind, where we invested lots of money in trying to understand how the brain functions, we're at the point now where we can begin -- I feel we're beginning to address those questions about how the brain functions and how we can change its functioning and improve its performance.

So my background, as I said, I'm a cognitive psychologist. I have had training in neuroscience, and that's my background.

I had worked for the Army for about 18 years, the Army Research Institute, and I've been at ONR for the last nine years.

DR. OHAB: Well, as we wrap up today's program, I wanted to give you the opportunity to add any final thoughts, if you have them.

DR. PEREZ: Well, yeah. I think we're at the beginning of a new science of learning, and that new science of learning will be the integration of neuroscience with developmental psychology, with cognitive science, and with artificial intelligence.

I foresee in the next five years that the kind of research we do on brain function will be multidisciplined and will involve people from not only the neurosciences, not only from the learning sciences, but from geneticists and biologists.

Because we're beginning to learn that genes and genomics have a lot to do with how you learn.

DR. OHAB: Well, thank you very much.

Our guest today is Dr. Ray Perez, program officer with the Office of Naval Research.

Thank you again for being here. This is some really important work. Please come again.

DR. PEREZ: Thank you.

DR. OHAB: Thank you very much.

Please tune in next Wednesday, January 20th (sic), when we are joined by Mr. Paul Ryan, the administrator of the Defense Technical Information Center, or DTIC. He'll be discussing a science and -- scientific and technical wiki known as DODTechipedia, which was designed to increase collaboration among DOD scientists, engineers, program managers, and operational war fighters.

Thank you again for your time today. Thank you for listening. I am Dr. John Ohab, and you have been scienced.

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