Future of Health Technology Symposium

Presentation by:
Alexander Libin, PhD
Senior Researcher, Neuroscience Research Center, National Rehabilitation Hospital

This podcast is presented by The Centers for Disease Control and Prevention.
CDC – safer, healthier, people.

Alexander Libin:
I would like to talk about completely different kind of robots. The robots that were designed for the purpose to communicate with human beings. And this program, I hope in the future will be part of the psychosocial rehabilitation program at the National Rehab Hospital where I work at the moment. And I think the form of our presentation, I'll give a brief overview of different psychosocial robots and then I'll ask Cleo to play with the audience and I was thinking I'll just let him go so each of you will have the experience of interacting with this robot. If you want to move closer, that's fine. If not, then I guess we will do an exercise. I'll jump ahead a little. This is a completely autonomous robot. It was developed as part of the NeCoRo project by the Omron Corporation in Japan, and we use it as a prototype for our future companion robot which will have many, many different features. For now this robot has only one button which is on and off switch, and she doesn't like to be turned off… And we'll treat her as if it were a real cat. The only rule is - don't try to do things you think a real cat wouldn't like, like pulling on the tail or pulling the hair.

I'll go ahead with the presentation. You can interrupt me and ask questions so we'll make it like a real interactive session because everybody is a little tired. The invention of the microchip brought new technologies to the field of medical rehabilitation. There are four groups of technology-mediated therapies which formed the early 21st century non-pharmacological methods of managing different disabilities and illnesses. So we have virtual reality of Internet-based communication and we've seen some wonderful examples today. By the way, I had this strange feeling when we had the robot on the stage to shake hands with Dr. Reynolds in Maryland although it was not possible, but maybe for some future developments. That might have been a nice application.

We have electronic games used for disease management, we have simulated environments and self guided trainings and there is an emerging class of new robots we call psychosocial robots, or robots with therapeutic potential. This table represents how various human needs correspond to the variety of robots that we have today. There is class of industrial robots, research, military, recreational robots, and we've seen some examples. And here is a special class of companion robots, still to be developed, although some of the basic features already are implemented in a few models that we will see later.

So what are the two basic defining features of the companion robot? First is that those robots who are designed for the purpose of communicating with a human being on a personal level; it can be done by different things and we will see there hare at least four basic factors that contribute to this companionship.

Another basic feature is that those robots have a life-like appearance, so to mimic human beings is kind of complicated so this is why we start with the animal based models. Some other features, I'll show a few short video clips to illustrate those points, the companion robots simulate a real life behaviors human-like or animal-like. They model emotional, cognitive and other mental states normally experienced by humans. This is Cleo's brother, kid Max and he's asleep now on the desk in Japan. It's really emphatic activity. And finally they give a person opportunity to communicate on different levels from tactile, which is a real important mode for many rehabilitation techniques, to emotional cognitive and social behavior. Some more features include an ability to maintain non-verbal communication. Or provide physical therapy for people with diminished skills like me, in that case with limited set of experiences. This robotic horse is built in Japan and there is a whole factory of those horses. It's a real-size horse that is used also in combination with the virtual reality environment and smell therapy. It's an animal robot, although its guided by the special software and can be programmed to move with the different speeds. So basically it serves two purposes. It provides rehabilitation for people with back injuries but also for the patients with social and emotional deprivation to enhance their sense of control, which I enjoyed very much riding it.

And finally going back to communication, various levels, I want to show you a video clip of the robot Ami, that is friend, if you translate it from French, this robot was designed by the Korean teams of engineers and those have a mount displayed on the body which serves a little different purpose. You can see this display communicates about the feelings of the robot, so the robot tried to recognize some specific voice patterns and can tell you through the digital display how it feels. The display has several human expressions from curiosity to satisfaction. It also changes colors and each color corresponds to a certain emotional state, and the heartbeat also symbolizes different mental states experienced by the communicating human. So of course people attribute it to the robot. And this is an interesting tool for both people after traumatic brain injuries and persons with autism who can actually enjoy this visual feedback.

Finally, we're getting closer to the cat. The robots .with the specific synthetic purr can enhance the tactile sense of interacting with people and this robot, Para, was called by the Guinness Book of World Records, the most emphatic and therapeutic robot. It was designed by the same researcher, who also was a leading part of the designing team work on Cleo and Max, the robotic cats. Para is an interesting model. This animal was chosen to neutralize all the experiences people have from their interaction with pet animals because what happens pretty often when you work with the cat in the hospital or on the therapeutic session, probably 50% of the people ask for a dog, not a cat. The answer is always no, we don't have a dog. What I'm saying is past experiences do influence certain responses or a certain level of enjoyment that people might experience

while communicating with a cat, still in our status with people with disabilities, specifically those with Alzheimer's and Parkinson's – mostly Alzheimer's, we've noticed that those past experiences didn't interfere with the intervention.

So there are many, many dimensions one needs to consider when building a companion robot. First of all, its appearance; how life-like the robot should be? Then it's a question of autonomy. Do you want this robot to be completely autonomous or do you want to have some kind of a button that can elicit certain reactions? And we will see later that for many groups with special needs, people with disabilities, physical or mental, cognitive impairments, emotional disturbance, those profiles are changing. So some questions or some issues that are obvious to ask are not so obvious when we emerge in the clinical context.

Of course its interactivity and then it's a question of how much interaction is needed for a very specific population. And finally it's a question about imitating behaviors. So all those are core questions in our ongoing project that we call robotic psychology and psychosocial therapy and I do have some slides with statistics. I don't know if I will be able to show it to you. If not, articles can be downloaded from our website. But what I want to say, we are trying to combine both qualitative and quantitative methods in our research because what happens mostly, you do a life-scale study, you get really good numbers, you have randomized control trial, repeated measures, research design with pre- and post- intervention measures and you have all these great statistics but sometimes numbers don't tell you exactly about the things you are interested in. So this is why the qualitative tests were invented and some of the most known focus groups and case studies design and graphic studies. In our case it was the study based on the website when we asked people to provide comments on what are the applications for the robotic cat, and I have some interesting and sometimes unexpected answers for suggestions for a new field application.

I would like to show you this diagram that explains what's inside this robot. It has 15 activators, 15 sensors. They correspond to human senses but I think we have only three for now; its sound sensor so Cleo can detect the direction of the companion. There is a video panel built in. I can tell you the secret that Cleo sees through her nose, not through her eyes. So eyes do correspond with movement but the video camera is in the nose part of the body. And the most important are attach sensors, so she can feel the direction and pressure of the touch and correspondingly she can respond in a way that the person is expecting. This is one of the main things we're trying to build our research on is to find what are the patterns that differ, say one disability population from another and the people with special needs from healthy people. We're wondering if people with a spinal cord injury, or children with a spinal cord injury have different reactions to the cat and they need a different companion than children who don't have the neurological disability.

As you notice, the cat with synthetic fur which is also helping probably 20% of the cases we have here in the U.S. are concerned with people having allergies. So we have very interesting cases. Last week we were at the nursing home and this 80-year-old woman

who never interacted with a cat in her life because she is allergic to cats. So her daughter was signing a consent form for this study was really concerned with this but since we had previous experiences that show people don't have an allergy to this cat. We told her that, and she was very happy to see her mother playing with a cat. She said I wanted it for her for a very long time and now she has this experience. And people do understand this is an artificial cat and it's not a substitute for the real pet. By the way there was an interesting interview about psychosocial therapy in the Washington Post. When people asked all different questions like ethical issues that this kind of robot should be in existence and is it a real threat. Before Kevin talked about threat to the human kind and cyborgs will take over; in this case it's a moderate threat but still they were asking, we would like to see robotic pets instead of the real animals and the answer is always no because when we talk about companion robots, I don't think we're talking about making them a part of our lives instead of something or as a substitute for say a human caregiver. We're talking about a certain type of intervention, in that case maybe a substitute for a drug, and this is why we call this approach psychosocial or non-pharmacological approach because what we found, and those were pilot studies and we hope to do it more rigorous, that people with depression, anxiety and especially people with agitation, say in acute care or in an Alzheimer's care unit, they do tend to benefit from this intervention. So we might expect the decrease in medication intake in the Alzheimer's unit and to find a better way to manage agitated disruptive behaviors than the drug intervention. Again, this cannot be a substitute for the drug in general but a balanced approach that might benefit a lot of people who already are taking lots of medications like nursing home residents.

Here is a little video clip so you can see what else this robot can do. So it can shake hands, which is not actually a cat's behavior, but people like it. I've never seen a real cat who can shake hands, normally it's a dog thing. But this is one of those factors that refer to mimicking behaviors. Is it a good or a bad? Those are all experimental questions. Okay, he didn't make it but he can actually stand on his …. So the cat cannot walk and that was also purposely done because it was designed as a companion for elderly people and mostly for people who are in need of companionship, for different reasons cannot have it. Again, our research was successful with the Alzheimer's patients and I know about the research that was done in Japan on children with immune problems and autistic children who also benefited from the interactions with the cat.

Now before we go to the numbers, here is some of the – after we had very good ….. something like three years to go, we got hundreds and hundreds of responses to this invention and which we were getting through our website and mostly people were sharing their experiences or asking how they can use the cat or offering their own vision of how this cat can be used, and that was done before we were doing any research. So some of those categories that we direct from the web comments were actually guiding our research in our future status. So I would like to give you some comments on the most common cat words which are the possible applications for this kind of companion robot. I have an 11-year-old son who was recently diagnosed with allergy-induced asthma, so how could …. inform us unless we wanted to make the hospital a permanent part of our lives? My son could in no way have a dog or a cat and that was a real

tragedy because Andrew really likes animals. Of course, all the names and places are changed. But when he saw the cat Max on TV, he was really excited and for the first time I saw hope in my son's face. So the allergies, asthma and immune problems right away identified an area for application and working with the National Rehab Hospital we did the trial on the pediatric unit and I'll tell you about those results in a few moments. We were able to show some of the statistical significant results for this intervention specifically when it comes to allergies and asthma.

Another comment: Wonderful is all I could say and I want a robotic pet now for my 85-year-old mom, a lover of animals but unable to care for one, this will be the answer to her bed companionship; just hope it purrs loud so the elderly could hear. So the social isolation, probably this should have been the first area of application. Social isolation due to age, illness or disability is one of the basic questions we investigated at the moment; how it can be a relief by providing people with the companion robot. And especially what are the psychological consequences of human robot companionship.

Another common concern, a person with a stroke. My father is in the nursing home after a stroke a couple of years ago and I know he would enjoy having Max as a companion in the home. Before his stroke, he loved visiting with us and our cats. Now not only people with disabilities or special needs considered Max or the robotic cat at their potential intervention. I was surprised by two next comments, here is one of them. I'm a paralegal; doesn't sound like much but the work behind the scenes in a law firm is very, very stressful. Even having Max on my desk to stroke and pet every now and then would be a blessing, not to mention the fact that every now and then we have young children in the office that need comforting due to their parents going through a divorce, separation or other painful issues. And probably one of the most amazing categories which was quite big was to have a robot cat as a companion for real animal. Here is one of the examples. I have a Siamese cat, and he is very jealous, so I don't dare get him another cat in the house but I think a robot cat might be a good companion for him. And actually our friend in D.C. who has a spinal cord injury has a dog and he's able to care for his dog but sometimes he feels the dog is kind of lonely, so we help him to buy a robot cat so the dog can play with the cat and have some kind of an animated toy in the house; and let it improve mental health for both our friend and the dog. I don't know about the robot cat, I didn't ask him. But actually, I'm wrong, I did ask and a couple of times when we had really intense presentations with a lot of people in the room, the cat gets really tired, and you can see it by slowing down or going into sleep mode. So we have a joke that after such an intense presentation, we provide robotherapy for the robot cat. But in that case the robotherapy is very easy, you just turn it off and it goes to sleep.

Now I would like to tell you a little bit more about the factors that we think lay the foundation of building a really successful companion robot. One of the factors that we briefly talked about is concern of appearance. There is an interesting hypothesis that came from a Japanese professor in 1970's. The meaning for this theory is that if robot is made more human like in its appearance and motion, the emotional response from human being to the robot will become increasingly positive and emphatic as we can see

here until a point is reached the response becomes increasingly stronger pulsive. And it goes down. What it says that the appearance and motion, if they continue to become less distinguishable from a human being or a real animal, then it really freaks out people. So they don't want the exact copy of a man or the exact copy of a cat. This is one of the reasons you're able to shake hands with the cat which a normal cat wouldn't do so you have this immediate unconscious response that you do understand that this is not the real animal. And we were concerned with this question when we worked with Alzheimer's patients who as you know, don't function very well in terms of cognitive awareness. What we noticed is they don't actually care about the artificial nature of this cat. I had several cases when I asked the patient, do you recognize this is not a real cat? And the lady said, yes and I don't care, I still like him. By the way, the same response we got from children with a traumatic brain injury and even for some of them who were not able to communicate verbally, we had the whole range of non-verbal positive responses that they do recognize that this is not a real cat and still they enjoy his companionship.

We go back to the slide we saw before where we identified four major factors that will make a companion robot successful. Those factors are actually mechanisms that can guide the configurations of the robot and also influence their physical appearance to be tailored to the specific needs of certain clinical populations. For instance, Alzheimer's patients, we've noticed that the level of interactivity really depends on the severity of impairment and this is why we need to have the robot with the open tool for programming so we can modify it for a specific group of people or even for this specific person. And hopefully in the future the robot can modify itself based on the feedback and responses; some kind of a database that can help to make the right decision.

The autonomy is a very important question. Like how much predictability the robot should have, or should the person be able to control the robot. For Alzheimer's patients again, the complete autonomy was not such a good thing and we were expecting the opposite that autonomy is good because you don't need to be with the patient and it's a cost saving intervention, etc., etc. But it turns out that for both Alzheimer's and children with a traumatic brain injury the question of autonomy is really important. Kids with TBI, they were looking for the button to push so the cat can turn its head left or right or pet the tail or look at them. And there was no button so they were a little frustrated. So maybe this is the place where a remote presence can be merged with this kind of technology so we have the nurse who say monitors 10 or 15 companion robots in the unit and can provide those responses for people who need this.

The opposite reaction of the medical stuff was – well, basically they also liked the intervention, but they were a little disappointed with the way the cat looked. They said, we want it to be more kind of toyish, we don't want it to be that real. And also they had the opposite sense of how autonomous should be the robot. They would like full autonomy, they don't want this button. So that was one of the moments we can really see a discrepancy in the perception of the clinician and the patient in terms of the patient's needs. Again, with the healthy children we learned that appearance is real important. By the way, can you tell which cat is which, like one of those is the real cat;

so this is the real cat and this is the robot cat. And for healthy children, again, interactivity and autonomy and all kinds of positive … were kind of on the side that we would expect they would be, so they wanted the robot to be more interactive, more autonomous, to be very real life looking. But for children and elderly disabilities the profile was a little different and sometimes inverted.

Okay, where is the cat? It fell asleep? It's still meowing? Because sometimes it needs a little warming up. If you put it on your chest and stroke it, it starts – it's like a relaxing therapeutic intervention for the cat. So once in a while we do this. Another thing is the software that this robot uses employs what's called ….. which is there is an input and an output but we don't know exactly how things are connected and this is what makes it interesting for people who are cognitively intact for healthy populations that you cannot predict the robot's reaction but you can learn from its behaviors what are the positive or negative responses and the cat has a variety of voice signals. I've never heard him hiss in the audience but normally it does it like half and half; it both hisses and meows so you can see it can be upset because people don't treat it right. I guess this audience is very well trained. After all, we're at CDC. So just a few numbers here. Our study involves now several hundred people across four different countries. The base is here in the U.S. but we also have colleagues in Japan, Russia, and Ukraine and we go there once in a while during our trip and do the study and we have different age groups and different clinical populations. We're trying to extend our .research procedures so the session lasts 15 minutes. We do behavioral observations using specific software. We designed a human robot interaction scale which you can read about in the article but this is one of the sub scales and some of the examples are the behaviors the cat can exhibit and how often people use this kind of …. like shaking the paw or turning …. or what kids like to do is kiss the robot cat and cuddling with it. Some of the cross cultural studies are really interesting. Just an example, in Japan people don't have a lot of eye to eye direct contact so those behaviors are not very appropriate in the context of this specific culture. So when we look at the results, we should consider not only clinical context but also a culture one, especially here in the U.S. when the whole culture is multicultural.

The study with dementia was based on the appropriate statistical model, it was repeated control design and for the control we used a non-interactive toy. Also a cat very similar to the one that has a computer inside. By the way, one of the reasons why this intervention is so successful in the nursing home is although pet therapy is extremely lovable and I do like this approach, sometimes it's just not possible especially for people with dementia who cannot control many of their reactions. Like with this person who tries to get the real cat. Sometimes the cat can sense that this person may not treat him or her right so they escape but Cleo never escapes, she always stays with you. She not only makes people happy but also what we found, there are two basic reactions to the intervention. People show some interest and sometimes a very distinct interest in the intervention and I should say those people are either heavily over drugged or they have years and years of experience in the nursing home environment or other confined environments. So mostly they are very empathic. And also this intervention is helpful in managing agitation. This is an example of the restless behavior,

and the same lady with the cat. So it's kind of similar to what Kevin showed us with the Parkinson's although this is a non-invasive therapy which can also work for some people better. So those are some slides on the statistics.

I guess I got to my conclusions. Those are the physical and behavioral configurations of the companion robot should be determined by the needs of target population. We cannot have a universal robot that will satisfy everybody, and I'm talking about companion robots of course. The robot that we saw with the tele-presence I think can satisfy any audience. Our study shows that companion robot triggers positive promotions and behaviors and this is the foundation for the relationships between the person and the robot. And finally, that those engaging robots with the different levels of artificial intelligence and all kinds of sensory input and output are able to create a communicative loop that is actually very similar to what we have in human to human communication.