Hospital tests potential for mind melds with machines

Using a sensor headset, children are helping researchers fine-tune technology for turning brain signals into real-world actions

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Adam Haggarty, a 15-year-old who has cerebral palsy and uses a hand-controlled wheelchair, tries the brain-computer interface with his mother, Joan, at the Holland Bloorview Kids Rehabilitation Hospital in Toronto. DEBORAH BAIC/THE GLOBE AND MAIL

Gisele Alnaser smiles as the sound of *Baby Shark*, a popular children's song, takes over a quiet boardroom. As the music plays from a pair of laptop speakers, her happy giggles give way to eyes full of excitement from the handful of people in the room.

Then, for a moment, everything goes silent. Gisele, in her jubilation, has lost her focus.

"Get it to play again! Clap, clap, clap," Gisele's mom, Samah Dawish, says to the six-year-old encouragingly. With a determined look on the young girl's face, it's only a few more seconds before the tune returns.

"Wooo, good job!"

Gisele didn't use her hands or voice to control playback. Rather, as one of 34 children testing a cutting-edge brain computer interface (BCI) at the Holland Bloorview Kids Rehabilitation Hospital, she used her mind.

Gisele, who was born with a mutation of a gene – CAMK2B – that plays a critical role in brain development, has experienced developmental delays that severely limit her mobility and verbal communication.

Since last year, she has been training on the Epoc-X headset, a BCI device from biotech company Emotiv.

Made of a series of sensors attached to a lightweight, helmet-like frame, the Epoc-X connects to a laptop and picks up brainwaves through conductivity with the wearer's head. Software called Mindset, designed by Holland Bloorview, then decodes those signals and converts them into actionable commands for the computer to execute.

While wearing the headset, children like Gisele are both users and data collection points, providing the Mindset software with information it can use to assess and predict the desired actions a wearer wants to make through the device.

To accomplish this, the software combines two techniques. First is teaching users "activation thoughts," or imagery and ideas that can be tied to a virtual action. Gisele's activation thought in many cases is clapping, which she uses to trigger the pause and play button on the *Baby Shark* video.

Susannah Van Damme, an occupational therapist and the program co-ordinator of Holland Bloorview's BCI clinic, says everyone will have a different preference for commands.

For example, some may choose prompts that directly reflect the action they are trying to take, as opposed to indirect prompts, such as Gisele's clapping command to start the video.

"If I were to think about playing tennis, and how I would move my arm to swing the racquet to hit the ball, that could be my active command," Ms. Van Damme says.

The second part of the equation is what she calls "quiet brain" activity, or periods where the user of a BCI device clears their mind of thoughts entirely. The Mindset software uses this to differentiate between actionable and non-actionable thoughts.

Ultimately, Ms. Van Damme says the goal of the BCI clinic is to refine the software so that children such as Gisele can use the technology to gain more control over their environments.

"The kids who will get the most out of a brain computer interface are the ones who can't access Siri or Alexa via voice and who have difficulty typing out on a computer," she says.

"This way, they just need to be able to use the patterns of their thoughts to accomplish what they want to accomplish."

Gisele's parents echo Ms. Van Damme with enthusiasm, describing the excitement of witnessing their daughter express her needs through BCI tech.

"It's all a bit thrilling to be honest," says Naser Alnaser, Gisele's father, who, like Ms. Dawish, works in IT and has a professional appreciation for communications-based technology.

"Sometimes you become a little emotional to see your daughter who cannot actually start a song or even communicate if she's hungry, or if she's thirsty. You see she actually can interact, she can play the things that she likes, she can talk to you, if she wants."

Another person in the BCI clinic is 15-year-old Adam Haggarty, who has cerebral palsy and uses a hand-controlled wheelchair.

Adam can communicate verbally and has a good degree of mobility. Still, there's a lot he'd like to do that he can't, such as being able to open doors without straining to reach for a wall-mounted button.

In a demonstration of the technology, Adam plays Alex Jumps, a simple video game created by Jason Leung, Holland Bloorview's BCI designer, which features a character running from left to right on a 2D landscape. Through the BCI, Adam controls when the character jumps to avoid obstacles and pitfalls.

While intrigued by its potential, Adam has his gripes with the tech. He finds the current single-action functionality of "on and off" options to be limiting and says he has a desire to be able to take complex actions more quickly.

He also understands that in order for the tech to improve, the software needs to analyze more users, which means his participation is crucial.

Luckily for the Holland Bloorview team, Adam finds the technology and the ambition of what it's trying to accomplish to be engaging enough to stay invested.

It's interesting "decoding the electricity into an actual thought, like integrating a brain with a computer, which is actually kind of a scary thought at the same time," he says.

Dr. Tom Chau, vice-president of research at Holland Bloorview, says that the technology is still in its infancy and still needs to be highly customized to work. "We realize every child is unique and has their own special preferences and has their own kind of abilities, so it's not going to be one single brain computer interface that's going to work for every child."

Looking forward, Dr. Chau points to the BCI clinic's next big development: a way for users to type and communicate with their minds.

Beyond that, he says the potential uses for BCI devices are "truly unlimited," citing examples such as being able to play instruments or drive cars with the help of BCI-controlled robotics.

"There really are no boundaries in terms of what can be enabled, because it's basically a connection to the outside world that you can control," Dr. Chau says. "Once that's enabled, and it's robust, there really is no limit to what you can do."