The potential of wearable devices for autistic people

Years ago, my MIT team and I were trying to build technology to read facial expressions, which would run inside a miniature wearable camera and whisper in your ear if the person talking to you was “interested, confused or agreeing”. This turned out to be relevant not only for many autistic people, but also for people with limited vision.

Today, you can download for free the app AffdexMe, which will automatically detect over 24 facial expressions (and no advertisements!) Companies also use this software to emotion-enable games, robots and more.

Autism and stress

While I was working hard on all of this, a smart autistic woman told me that I was solving the wrong problem. She said: “My biggest problem is not understanding the emotions of others. My biggest problem is you are not understanding my emotions.”

I sought to learn more -- Was it just me? I knew I could improve, but was I really THAT awful? She reassured me that it wasn’t just me: most people misunderstand her emotions. And it’s not just her: most autistic people are misunderstood.

I asked what kind of emotions we were missing. She said “stress, enormous stress.” I spoke with many more autistic people and their families. I heard stories that sensory experiences, fluorescent lights, background sounds and many other things were causing enormous stress, but neurotypicals didn’t see it.

Furthermore autistic people, with full language, described that they themselves could not feel or see their own stress building until it was too late.

“I wish I could get an alert of the stress climbing before I have a meltdown, but I can’t, and by the time I recognize it, it’s too late.”

Using technology to identify stress

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I realised that my lab at MIT had technology that could be adapted to help identify when people are experiencing stress.

I started with a pair of electrodes and a small circuit used to measure the physiology of stress, in particular its autonomic arousal component. The simplest interpretation of this is that you sweat when you are fearful, anxious, nervous, or encountering a significant, high-stakes or potentially threatening event. When you sweat, your skin becomes more conductive.

We measured the electrical changes in the surface of the skin – non-invasively – to capture what the scientists call “electrodermal activity” or “EDA”. The circuit can also pick up changes when you don’t feel any sweat on the surface of your skin. When certain regions in the brain are activated, they activate a network of sudomotor nerves underneath your skin, and these can change the conductance.

**Detour into epilepsy**

While collecting a lot of data from people and looking at stress and calm episodes, at one point the EDA wrist sensor picked up a signal on a boy that was huge – so over-sized that I thought the sensor must be broken. When I went back to try to figure out what had gone wrong I learned that the sensor was not broken at all. In fact, it had picked up the most dangerous kind of seizure – a grand mal or Tonic-clonic seizure.

We learned that what we were measuring on the wrist could be used to build a more accurate grand mal seizure detector. We also learned that it is important to issue an alert when somebody has a grand mal because in the minutes following, it is possible for respiration to stop.

**Embrace** is now certified as a medical device for convulsive seizure detection in the European Union, and is undergoing evaluation by the Food and Drug Administration (FDA).

**Future plans for an autism application**

Now we want to finish what we started. Today, Embrace can tell you the time, your sleep/wake schedule and activity levels and, if you have epilepsy, it can issue a potentially life-saving alert. Embrace measures exactly what is needed to enable an alert when your EDA is climbing, which it is likely to do before a meltdown.

We need to develop new software to make this applicable for autistic people, to make it easy to get meaningful alerts and to know what to do with their EDA data. Here are some ideas of what might be possible:

Suppose that a non-speaking student is experiencing high levels of stress/anxiety causing them to get distressed and the staff does not understand what is causing it. Suppose the trigger gives rise to a change in the EDA signal that can be captured on the wrist. The staff can look at the EDA on a timeline and see when the signal started to go up. For example, did it start to climb when a mechanical fan turned on, or when perfume-laden Priscilla entered?
While it may not always be easy to identify the cause, the device may at least help pinpoint the timing of the cause. Finally, what if you could see in real-time when your signal is starting to climb and get a gentle vibration on your wrist, or send a subtle alert to the wrist of your teacher or partner, so they could be aware of the changes? Might it be possible, with this added insight, to catch triggers early? Then perhaps a person would have a better chance to adapt to the situation positively (perhaps breathing, or getting into a new space, or getting somebody to turn off the fan).

This is what we are attempting to create with our future app which will run on the Embrace wrist device.

**About Empatica**

Empatica builds wearable devices with clinical-quality sensing capabilities, making lives better for all people, especially those with neurological disease. The company's first product, the E4, is the world's smallest and most accurate wearable that continuously measures human physiology and behavior, providing medical quality data for researchers in the European Union (EU). Empatica sells the E4 worldwide to the best universities, research centers, hospitals and pharma companies, where it has been used in hundreds of research and clinical studies to collect data.

Empatica was founded by Matteo Lai, Simone Tognetti, Maurizio Garbarino and Rosalind Picard. It has offices in Cambridge, MA and Milan, Italy, with production in Seoul, South Korea. Empatica is privately held with funding from individuals. Its products include the E4 wearable biosensor, the Embrace smartwatch, and a suite of cloud-based software tools and analytics, including advanced machine learning and signal processing for characterizing physiological events.

Empatica started to work on seizure detection after a serendipitous finding during a stress-measurement session with a non-speaking child with autism. When the child had a seizure, unexpectedly the signal on his wrist (measured for stress) developed a very unusual pattern, which Picard initially believed indicated that the sensor was not working. After follow-on investigations, she realized it was working quite well, and in fact a key signal it measured was highly correlated with brain wave suppression that occurs during sudden unexpected death in epilepsy (SUDEP). In Nov, 2016, Empatica was recognized with the “Alexander Fleming Serendipity Prize” for developing a successful product based on this surprising finding.