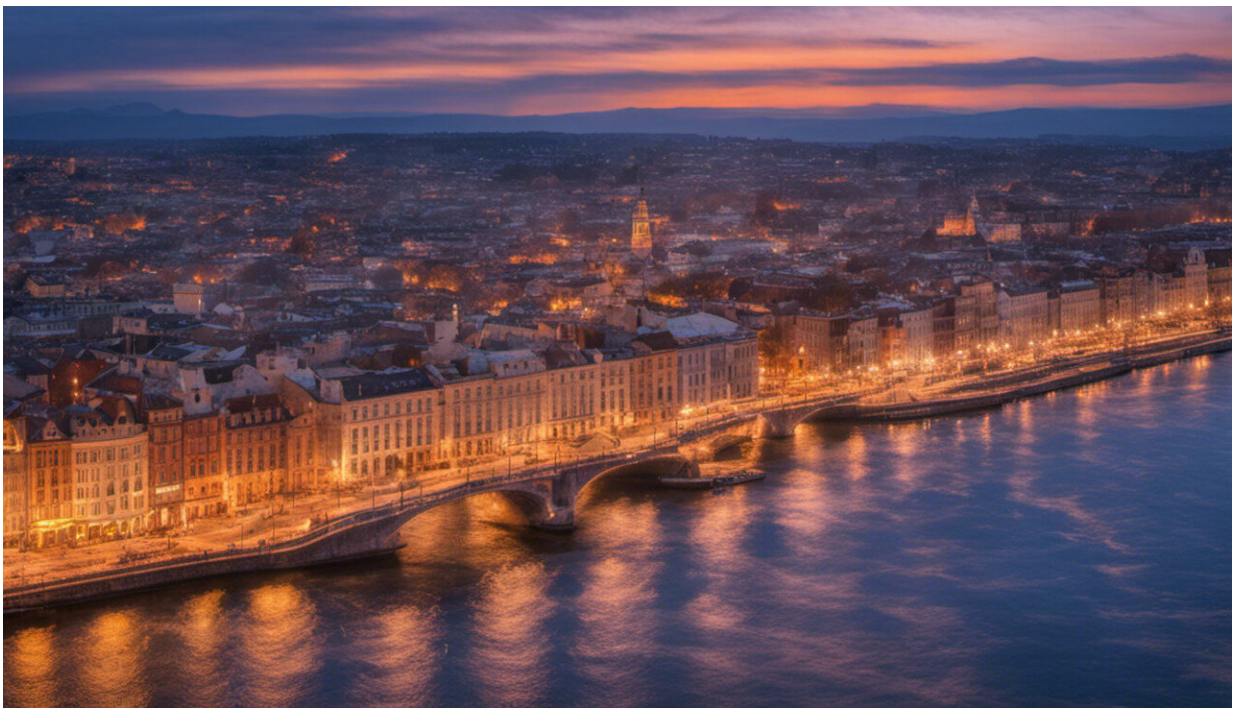
Your mobile phone knows where you go and what you do – and maybe even when you're feeling down

August 4 2015, by Sohrob Saeb



Credit: AI-generated image (disclaimer)

Today's smartphones are equipped with powerful sensing capabilities. Using these sensors, your smartphone potentially has a record of how active you are, how much you sleep and where you go. If we look at the data those sensors gather, we can get a pretty good idea of what

someone's typical behavior is like.

When a person is depressed, their behavior often changes. You may lose interest in activities, experience changes in your sleep cycles or withdraw from social interactions. And your phone, typically close at hand, could be used to detect these behavior changes.

In a study recently published in the *Journal of Medical Internet Research*, we investigated whether a person's movements and activities as recorded by their smartphone signaled behavioral changes associated with depression. And we found that they are, in fact, closely correlated.

How did we use smartphones to detect depression?

We recruited 28 participants, 14 with depressive symptoms and 14 without. We started the experiment by quantifying their depressive symptoms by using a test called patient health questionnaire (PHQ-9). The PHQ-9 consists of nine questions asking about the presence of several symptoms of depression such as loss of interest, hopelessness, changes in sleep, tiredness and having trouble in concentration. It's a very common test. In fact, you might have taken it at your last doctor's appointment.

Then we collected data on GPS location and phone usage recorded by the built-in sensors on each participant's phone for two weeks. We also developed a sensor to calculate how long and how often participants used their phones. It tracked all phone activity except for calls.

Then, we developed algorithms that estimated certain behavioral markers that we thought might be related to depression. These markers included the patterns of movement though geographical space, the total distance a person moved during the two-week period, the number of locations visited, the speed at which the individual moved between

locations, and the amount of time he or she spent in different locations.

Finally, we analyzed the relationship between these markers and the severity of depressive symptoms.

Which behaviors can identify depression?

We found that a number of behavioral markers strongly correlated with PHQ-9 depression scores. These included markers that captured patterns of movement, mobility, the time spent in different locations, and phone usage duration.

Participants who were more depressed had more irregular movement patterns. This means that, for example, they left home for work at a different time each day, while less depressed individuals went to work around the same time every day.

In addition, the more depressed participants were less mobile and spent most of their time in fewer locations. We also found a correlation between phone usage and depression scores. The more depressed participants used their mobile phones more often and for longer periods of time, but not for making phone calls. This activity may have included texting, playing games, reading or other activities.

Pushing mHealth beyond treatment to diagnosis

This study used a relatively small sample, but still an interesting piece of evidence on how mobile phones could detect symptoms of depression.

Another study from Dartmouth College used mobile phone sensors to look into several aspects of students' lives, and also found a number of them, including sleep, sociability, and physical activity, to be correlated

with depression. We still need to see what happens with a larger group of people to see what daily-life behaviors are related to depression in the general population.

As mobile phones have become more ubiquitous, they have become important tools for health care. This is called mobile health, or mHealth for short.

mHealth interventions are effective, and are part of national health care systems in many European countries and Australia.

mHealth is sometimes used to assist with diagnosis. For example, in mobile telemedicine, patients can provide information, such as a picture of a skin injury, to their doctors using their mobile devices.

In mental health care, mHealth has been used to monitor mental health patients by sending them daily questionnaires about their mood and daily activities either through SMS or specialized smartphone apps.

However, without human support from therapists or coaches, patients tend not to use these tools. In addition, patients repeatedly need to input data about their mood and behaviors, mostly a few times per day, which is a major factor in their non-adherence to the treatment procedure.

For people at risk of depression, our research means that their health can be passively monitored without any burden on their side. They don't need to input data about their mood, daily activities or sleep quality, and care providers can check in if they see a behavior that needs more personal support.

In addition, mobile phone data could also help clinicians understand how depressive symptoms and depression change over time. This could help us develop better treatments or strategies to help people with depression.

Depression is fairly common – about 6.9% of US adults have at least one major depressive episode each year – so this could really make a difference.

More than two-thirds of all depressed patients want psychological support, but more than 70% of them face barriers such as high costs, transportation, stigma concerns and lack of motivation that make it hard to access traditional psychotherapy.

mHealth can help overcome these barriers by eliminating the need to have regular, usually costly, visits with the therapists and the need to transport, and provide care to those in need in place.

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