

SMARTY BRAINS – Glimpses of Digital Revolution in Dementia Care

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Jack Lyon, 76 years, a retired teacher, has been forgetting a lot. He forgets his medicines, his way inside the home, and sometimes even who he is!

At times, Jack even forgets his own struggles about forgetting.

He lives alone with his caregiver. Things tend to get really difficult, and at times Jack is totally lost in a web of confusing memories, that he cannot choose from.

Until he was gifted his savior – *Maggy*.

Maggy has sketched a 3-D house map for Jack with each room marked by a different color and highlighted with fluorescent strips. She creates a new routine throughout the day incorporating what Jack likes and prompting him at every step. Maggy also takes him back to his past based on the islands of existing memories and thoughts – where Jack can live his ‘own’ world. Maggy detects his vital parameters including heart rate and blood pressure variation to know whether he is hungry or thirsty or if his bladder needs to be evacuated. The GPS tracker on Maggy alerts Jack’s caregiver immediately if he wanders off a certain radius beyond his house, and finally his metabolism patterns tell Maggy if he has missed medications in spite of reminders and she immediately ensures that the pill is taken.

Maggy has been Jack's closest companion, yet others cannot see her.

The reason being Maggy is the *virtual AI-based dementia* care assistant to Mr. Lyon, connected through his Google lens. Maggy has access to his smartwatch, GPS tracker, blood pressure and

oxygen saturation monitors, and other electronic devices in the house, including the security systems.

Does this seem like an implausible yet entertaining Nolan SCI-FI flick?

Surely, but there is a high chance that it will be a real medical intervention in the very near future.

THE PROBLEM PREMISES

The world has been aging fast and with this demographic shift, there have been several biological and psychosocial challenges for older adults. One such public health challenge is that of dementia, an illness that leads to a gradual decline in one's memory, behavior and other forms of brain functioning. Being a neurodegenerative disorder, dementia does not have a definitive cure but there have been leaps beyond horizons in its management over the recent years.

Following the age-old dictum *'Use it or lose it'*, the key is to keep the brain active and tickling for healthy aging and even for those with dementia. As long as the person continues to be active even with assistance, there is a hope for delay in progression.

The recent innovations in psychogeriatrics necessitate a separate book of their own and are too elaborate for a crisp presentation.

Let's look at some of the apparently 'SCI-FI seeming' upcoming innovations in dementia care that have the potential to revamp cognitive neuroscience.

We shall be looking at AI-based cognitive stimulation techniques, sensors and smart home technologies.

USE IT OR LOSE IT

In those affected with dementia, cognitive stimulation and cognitive rehabilitation are evidence-based measures to improve the brain functioning of a person; and like many other health modalities, digitalization and use of artificial intelligence have revolutionized such restoration of brain health in dementia.

Often, an anthropoid holographic representation is given to an AI-based assistant incorporated in an audio-visual device (like lens, hearing aid or skin-sensors, etc.) which can guide the person with dementia in their daily chores, also monitoring for their security and health.

Besides, navigation and medication assistance, these AI-based models are equipped with sensors to detect physical biomarkers of an individual and create machine-learning based predictions about his/her mental state, physiological needs and goal-driven actions. As such, they can predict and prevent behavioral and psychological symptoms of dementia (BPSD).

For example – playing one's favorite music or displaying one's birthday pictures from the database when agitation is predicted from his physiological or situational cues.

Such a model has been developed jointly by the University of Massachusetts and the Harvard medical school as is currently under pilot testing.

Not only for patients, AI-powered diagnostic aids can be efficient and fast in the diagnosis of dementia as well, especially while struggling with limited staff and training.

Time is the essence in such a progressive condition, hence earlier the detection – the greater window for interventions!

Neuropsychological tests used to detect dementias are often elaborate, manpower intensive and time consuming – mostly being paper-pencil and not digitalized in many settings.

So, what about using a digital algorithm?

A new AI tool that could help doctors assess the early signs of dementia and Alzheimer's more quickly and efficiently, has been developed by researchers at the University of Sheffield.

The system, known as *CognoSpeak* uses a virtual agent displayed on a screen to engage a patient in a conversation. It asks memory-probing questions inspired by those used in outpatient consultations and conducts cognitive tests, such as picture descriptions and verbal fluency tests.

The tool then uses artificial intelligence and speech technology to analyse language and speech patterns to look for signs of dementia, Alzheimer's disease and other memory disorders.

Researchers behind the technology have mentioned that *CognoSpeak* could play a key role in reducing the burden on dementia assessment services

SENSE THE SENSORS

Digital phenotyping refers to the quantification of a symptom or behaviour using a variety of different sources of data collected moment-to-moment in daily life. In the context of dementia care, sensors can be wearable and used to measure movement, location, various physiological markers, and environmental exposures (light, sound, temperature). Sensors in beds can be used to assess physiological measures of sleep. Sensors are also often embedded in the environment to track movement and interactions within the milieu (i.e. opening of doors, turning on taps). Finally, computer vision-based sensors are able to “watch” for facial expressions and posture. Importantly, to transform sensor data into clinically useful information, it is necessary to find important features and patterns in the data. This process is termed data mining and often involves modeling using advanced machine learning. The aim is to develop a system capable of capturing clinically meaningful information and capable of using this real-time data to provide warnings or make predictions that have a meaningful impact on clinical decision-making or patient care.

Given that such predictions are probability-based models that can never be 100% accurate, they can definitely showcase a trend in cognition and behavior.

LIVE SMART

Smart home technologies can enable older adults, including those with dementia, to live more independently in their homes for a longer time. Activity recognition, in combination with anomaly detection, has shown the potential to recognise users' daily activities and detect deviations.

Smart homes are ambient assisted-living environments equipped with smart technologies (both hardware and software) to assist users in performing their daily activities. Sensor devices play a crucial role in smart homes, allowing the continuous monitoring of occupants' daily activities. Smart home sensors fall under three main categories: ambient sensors, wearable sensors, and visual sensors.

Ambient sensors, such as passive infrared sensors (PIR), pressure sensors attached to the bed or couch, and contact switch sensors (CSS) attached to doors or closets, can capture activities such as walking, sleeping, or exiting the house, respectively.

Wearable sensors (accelerometers, gyroscopes, wrist watches, and heart rate sensors) can monitor users' physical activities and physiological measurements.

Visual sensors, such as video cameras, can capture and record different user activities and provide accurate insights. In the context of dementia, smart home technologies can be used to monitor and support the patients as they accomplish their daily activities, thereby allowing them to live more independently and safely for as long as possible

Ambient sensors are non-intrusive and effective for detecting activities, as they are easy to deploy in homes and guarantee users more safety and privacy than wearable and visual sensors.

THE FORWARD GAZE

True that many such technologies are great to imagine but difficult to digest outside movies and the pages of fiction – however, same was the case hundreds of years ago, when people couldn't necessarily envisage even a computer!

Several questions arise:

- *Can AI supplement the role of an individual?*
- *Degree of accuracy?*
- *How many people in LMIC will be able to afford and use such technologies?*
- *Is all the investment and research really worth it?*
- *How much of this improvement will translate into real-life betterment of the person and the family?*
- *Digital ethics, data confidentiality and risk of hacking*
- *Need for technical support (just like any new innovations)*
- *Will the protocols and guidelines for use be too complex?*
- *Are we being too optimistic?*

There may be several more such questions, but how they are answered by researchers working in this area – will decide the degree of hope with which we can dream!

Notwithstanding such scepticism, the digitalization of dementia care is a much-needed step for this ever-growing public health concern, which has been substantiated by organizations such as the World Health Organization (WHO) and Alzheimer's Disease International (ADI).

At every step, these services need to co-exist with the existing treatment strategies – caregiver education, anti-dementia medications and behavioral techniques for improving cognition and behavior. An integrated approach will always fetch the best result.

With the intersections of speedy aging and rapid digitalization – it's imperative that virtual reality, machine learning, AI based models and digital security will revolutionize dementia research and care, but given the challenges of digital literacy, network connectivity, cost-benefit scrutiny, ethics and political will – how much the present innovations stand the test of time will be a thrilling 'wait and watch' game!

Till then, let us hope that individuals like Jack Lyon, who are living with dementia, live a happy and healthy life, with the care of Maggy.

Conflict of interest: None

Key References

Macaden L, Muirhead K, Melchiorre G, Mantle R, Ditta G, Giangreco A. Relationship-centred CogniCare: an academic–digital–dementia care experts interface. *Working with Older People*. 2021 Jan 22;25(1):73-83.

Richardson A, Robbins CB, Wisely CE, Henao R, Grewal DS, Fekrat S. Artificial intelligence in dementia. *Current Opinion in Ophthalmology*. 2022 Sep 1;33(5):425-31.

Harwood T, Mukaetova-Ladinska E, Maltby J. Role of Artificial Intelligence (AI) art in care of ageing society: Focus on dementia.



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