Tablet-based diagnostics

TuCAN - innovative diagnostic procedure for neuropsychiatric disorders

Neuropsychiatric disorders are often diagnosed late and have a negative impact on quality of life. Diagnosing the disease at an early stage is vital to be able to help those affected by offering them treatment adapted to their specific requirements. This is what the TuCAN project in Tübingen aims to achieve through the early and differential diagnosis of neuropsychiatric disorders.

In Germany, 1.5 million people suffer from dementia[1)], a neurodegenerative disease classed under neuropsychiatric disorders. Neurological, chronic progressive diseases are caused by the degeneration and death of nerve cells. People with dementia suffer from multiple cognitive deficits, which affects their ability to function in their everyday lives. At present, available therapies are only able to slow down the onset of symptoms and the progression of the disease. There is as yet no cure for neuropsychiatric disorders.

Neuropsychiatric disorders therefore need to be detected through early and differential diagnosis, and immediate therapy is required to slow down the progression of the disease. Psychological test procedures such as the 'Montreal Cognitive Assessment' (MoCA) test – a pen-and-paper test – are commonly used to make a diagnosis. Patients are given tasks to assess cognitive abilities such as memory, language, temporal and spatial orientation, and attention. The test is normally performed in a local hospital or in a doctor's practice and the physician evaluates the test manually using lists of criteria. Conventional pen-and-paper tests are therefore not only time-consuming, but make it difficult to obtain all the parameters required for a comprehensive diagnosis.

Infobox

Neuropsychiatry:

Neuropsychiatry deals with cognitive and mental disorders of organic origin (e.g. depressive, schizophrenic forms, delirium and obsessive-compulsive symptoms or movement disorders) and is located on the border between neurology and psychiatry. Neuropsychiatric diseases are caused by organic pathomechanisms such as inflammations, infections or metabolic disorders.
Epilepsies, neurodegenerative diseases, basal ganglia disorders and autism spectrum disorders are among the classic neuropsychiatric diseases.[2), 3)]

Neurodegeneration:

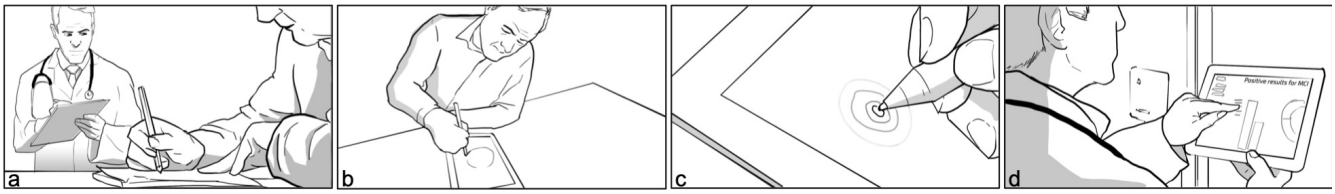
Neurodegenerative diseases, which are also classed under neuropsychiatric disorders, are diseases of the nervous system. They are caused by the degeneration and death of nerve cells of the central nervous system. Neurological and psychiatric dysfunctions such as disorders in the sense of direction, memory, orientation and motor function are consequences of the progressive loss of nerve cells. The best-known neurodegenerative diseases include Alzheimer's disease, Parkinson's disease and amyotrophic lateral sclerosis.[4)]

Faster and more precise diagnosis using rule-based evaluation combined with machine learning

Psychologist Christian Mychajliw and his team now want to change this. Mychajliw, who is responsible for science and organisation in the project, and computer scientist Heiko Holz came up with the idea for the TuCAN project - Tübingen Cognitive Assessment for Neuropsychiatric Disorders - in 2018 through an article which described the digitalisation of a common pen-and-paper test. The initial idea to optimise the evaluation of digital pen-and-paper tests described in the article resulted in a cooperation between the Department of Media Informatics and the Geriatric Centre at the University Hospital of Tübingen.

As part of research work and theses, the six-member team is developing tablet-based innovative and valid procedures for diagnosing neuropsychiatric disorders. Physicians and psychologists can use the app to perform tests and subsequently receive the processed and evaluated results. As well as saving time for both patients and physicians, there is another advantage: "By digitalising what was previously a pen-and-paper-based task such as that used to diagnose neuropsychiatric disorders, the app enables additional parameters such as processing time, movement sequences and pressure strength to be collected. These parameters are then included in the creation of evaluation models, thus allowing a statement to be made on mild cognitive impairment or incipient dementia that is much more accurate than that based solely on the results of a conventional pen-and-paper task. This can also be done earlier in the course of the disease," says TuCAN app developer and technical director Heiko Holz.

The team began their work by digitalising the clock-drawing test, which is commonly used to screen for dementia. Patients are asked to draw a clock. Any errors in the drawing such as missing hands or numbers allow conclusions to be drawn about whether a person is showing signs of dementia. "Healthy people proceed much more systematically than people with incipient dementia," Heiko Holz reports. More information on whether a person is showing signs of dementia can be obtained from additional parameters collected by the digital test version, which makes it possible to identify a larger number of people suffering from initial neuropsychiatric symptoms, such as slowed movements, tremors or



a) Pen-and-paper tests are usually performed by physicians to diagnose neurodegenerative diseases. b) The tablet-based diagnostic tool developed by TuCAN enables the patient to perform a digital pen-and-paper test directly on the tablet using a digital pen. c) More data can be collected using modern digital technology. These additional parameters that are collected include, for example, movement sequences, pressure strength during writing and drawing, and the time it takes the patient to complete the task. d) Research has shown that these additional data make it possible to identify signs of a neurodegenerative disease earlier and more accurately. The automated evaluation process saves the physician time and resources.
© TuCAN team

disorientation. In addition to using rule-based evaluation to identify what kind of clock the patient has drawn, digital parameters are used to train an evaluation model using machine learning. This helps physicians to make a diagnosis. "Combining a standard evaluation approach with a more objective and faster evaluation procedure helps save time and improve accuracy. This is key in the many assessments required," explains Franz Wortha, who is in charge of machine learning in the project.

To collect their data sets, Mychajliw and his team are participating in the TREND study - Tübingen Evaluation of Risk Factors for Early Detection of NeuroDegeneration. The study aims to detect symptoms and the progression of neurodegenerative diseases as early as possible in order to be able to start neuroprotective therapy at an early stage. In addition, data sets are also being collected in smaller studies, which the research team is incorporating into its evaluation models.

Interdisciplinary project team with ground-breaking plans



TuCAN team (clockwise from the left): Franz Wortha, Heiko Holz, Christian Mychajliw, Kristina Dawidowsky, Christoph Gäbele and Louisa Sting along with the TuCAN mascot.
© TuCAN team

Despite the lack of financial support, which is a fairly major obstacle that still has to be overcome, the team, composed of psychologists, cognitive scientists and computer scientists, are full steam ahead with the project. In addition to improving patients' quality of life, Christian Mychajliw explains that the team is driven by the goal of "using early disease diagnosis to contribute to finding promising therapies that show improvements at an early disease stage, but which have not led to success in some pharmaceutical studies because the disease was already too advanced at the time the patient was included in the study".

The interdisciplinarity and cross-functionality of the team is the key to the project's success. It received funding through the BMBF's 'Start-ups: Innovative Start-ups for Human-Technology Interaction' programme from 2018 to 2022. The researchers developed the core of the project during this funding phase, namely an app into which some diagnostic tools have been integrated, and which will be available to physicians in the future. The app will be expanded further to include voice-based tasks in addition to conventional pen-and-paper tasks for disease diagnosis. The researchers also have the long-term goal to enable differential diagnoses in order to provide patients with therapies more tailored to their specific impairment.

It is not just the project team that sees potential in the project: TuCAN has participated in several competitions in addition to the MedTech Startup School of the Life Science Accelerator. These included MobileHCI 2018 in Barcelona, where the team won the Poster Award. The team also came third in the Startup:con Tübingen 2021 Start-up Pitch and third in the BioRegio STERN Management GmbH Science2Start competition in 2022.

However, the team has further goals in mind: it has its eye firmly set on establishing a company and is seeking follow-up funding for the TuCAN project for this purpose. It hopes that this will secure the development of innovative and valid diagnostic tools that contribute to maintaining patients' quality of life for as long as possible.

References:

1) Süddeutsche Zeitung: "Demenz - das große Vergessen". https://www.sueddeutsche.de/wissen/podcast-recherche-demenz-deutschland-angehoerige-1.5582485?utm_source=bing&utm_medium=cpc&utm_campaign=B_DE_Podcast_Thema_Folgen_Generic&utm_term=alzheimer%20deutschland&utm_content=B_DE_Podcast_Thema_Folgen_Demenz_Generic

2) Deutsche Gesellschaft für Psychiatrie und Psychotherapie, Psychosomatik und Nervenheilkunde e.V.: "Neuropsychiatrie". https://www.dgppn.de/die-dgppn/referate/neuropsychiatrie.html

3) Price, B.H.; Adams, R.D.; Coyle, J.T. (2000). "Neurology and psychiatry: Closing the great divide". Neurology 54 (1): 8-14

4) vfa Patientenportal: "Was sind neurodegenerative Erkrankungen?" (2020). https://www.vfa-patientenportal.de/erkrankungen/neurodegenerative-erkrankungen/was-sind-neurodegenerative-erkrankungen.html

Article

12-Apr-2023
Friederike Zängle
© BIOPRO Baden-Württemberg GmbH

Further information

Christian Mychajliw
Phone: +49 (0) 7071 29 85358
Email: christian.mychajliw(at)tucantest.org

- TuCAN

The article is part of the following dossiers



Telemedicine: advances in high-tech healthcare



Artificial intelligence in medicine: assistance for human senses

diagnostics | neurodegenerative diseases | neurology | company foundation | digitalisation | machine learning | Mental Illness | Startup