Communication between brain areas is crucial for the brain to correctly process sensory signals and adopt an appropriate behavioral response. Yet, dysfunctions in these communication pathways could be strongly correlated with the onset of schizophrenia. For the first time, a team from the University of Geneva (UNIGE), Switzerland, within the framework of the Synapsy National Centre of Competence in Research, has succeeded in demonstrating this phenomenon in human beings. By carrying out analyses of the brain activity of children, adolescents and young adults with a genetic risk of the disease, the research team has demonstrated that a reduction in the activation of gamma waves, that are known for their role in the proper transmission of information in the brain, was correlated with the emergence of psychotic symptoms even before full-blown disorders appear. This work, published in the American Journal of Psychiatry, makes it possible to envisage a very early diagnosis.

In the mammalian brain, the electrical activity of neurons responds to oscillatory rhythms that can be detected by electroencephalography. The coordinated activation of these different waves, which governs, for example, the processing of sensory inputs or the consolidation of memories, enables the brain to function correctly. "We suspected that gamma waves, the highest frequency of the brain rhythms, play a decisive role in the development of schizophrenia symptoms," say Stephan Eliez, professor in the Department of Psychiatry, and Christoph Michel, professor in the Department of Basic Neuroscience, who co-directed the research. "However, we still had to confirm that this impaired synchronization of neural communication pathways observed in mice does indeed exist in humans."

Genetic predisposition

People with a chromosomal microdeletion 22q11 have a 25 to 30% risk of developing schizophrenia in adulthood. "They are therefore a particularly relevant at-risk population for studying the cerebral development of this disease," says Valentina Mancini, a doctoral student in Stephan Eliez’s laboratory and the first author of this study. People with schizophrenia often suffer from reduced
capacity to process auditory information; in order to
detect any disturbance in brain communication, the
scientists therefore measured gamma wave
activation following an auditory stimulus in 22q11
patients of all ages, compared with people without
this microdeletion.

"Children and adolescents at genetic risk of
schizophrenic disorders but without visible
symptoms showed the same patterns of gamma
wave disruption as patients actually suffering from
the disease," explains Vincent Rochas, a scientific
collaborator in Christoph Michel's laboratory. In
addition, a linear growth of the gamma-band
oscillations was observed in people with no genetic
predisposition to schizophrenia, showing a
progressive maturation of communication between
the cerebral areas during development. "However,
this maturation is absent in 22q11 patients,
whatever their age, suggesting an abnormal
development of circuits underlying neural
oscillations in adolescence," stresses Valentina
Mancini.

Intervening as early as possible

The research team also identified a strong
correlation between the gamma-band activation
deficit and the severity of psychotic symptoms,
such as auditory hallucinations, thus confirming the
existence of a neurobiological progression of the
disease. "Our results confirm that this dysfunction
appears very early," the authors emphasize. "We
now want to identify the best time during the child's
development to intervene in relation to this
pathological shift."

Moreover, studies on mice show that targeted
neuroleptic treatments succeed in correcting neural
dysfunctions; in addition, the gamma-band
impairments identified here could be restored using
techniques of non-invasive neurostimulation
targeting the affected brain regions, thus opening
the way to completely new therapeutic perspectives
for treating an often devastating disease.

More information: Valentina Mancini et al,
Aberrant Developmental Patterns of Gamma-Band
Response and Long-Range Communication
Disruption in Youths With 22q11.2 Deletion

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