EEG Based Biomarkers for Classifying Patients Treated for Congenital vs. Developmental Cataracts

In a new study from the L V Prasad Eye Institute (LVPEI) and Biological Psychology and Neuropsychology (BPN) at the University of Hamburg, researchers were able to differentiate between sight recovered individuals with a history of dense, total bilateral congenital vs. bilateral developmental cataracts using a neural marker of visual processing. The findings could aid clinical prognosis and rehabilitation, clinical research on treatment outcomes, and epidemiological studies on the genetic origins of cataracts. The results were published in *EClinicalMedicine*, a journal published by *The Lancet*.

Childhood cataract is one of the major causes of avoidable blindness worldwide. Dense cataracts prevent pattern vision, allowing only diffuse light to reach the retina through the clouded eye lenses. Cataracts in children can have congenital or developmental origins, and typically, these distinct origins have different expected outcomes after sight recovery.

Using electroencephalography (EEG), faint electrical activities of the brain can be picked up on the scalp surface in a non-invasive and safe manner to investigate information processing in the brain. In a cooperation between BPN and the LVPEI, researchers used event-related potentials, an EEG signal, to trace the multiple stages of visual processing in the brain. Earlier studies of the team demonstrated a timely arrival of visual information at the first cortical processing stage, and a spared basic organization of this area in congenital cataract reversal individuals even if surgery had only been performed in late childhood. By contrast, event-related potentials indexing the consecutive stages of visual processing were found to be altered in this group, for example, those associated with face processing.

The present study employed the *P1 wave*, an event-related potential measurable after about 120 ms of the presentation of visual stimuli. The P1 wave is prominent on the posterior portion of the head, where the visual cortex is located. From previous research it is known that this event-related potential originates in higher visual brain areas, following the initial arrival stage of visual information.

In two experiments, event-related potentials were recorded from 86 participants while they watched simple visual stimuli. As predicted, the P1 wave was attenuated in the congenital cataract reversal individuals compared to typically sighted controls, whereas developmental cataract reversal individuals were indistinguishable from typically sighted controls based on their P1 amplitudes. Importantly, using the P1 amplitudes, the researchers were able to develop biomarkers to tell apart a history of congenital pattern vision deprivation from a history of developmental pattern vision deprivation. The biomarkers, developed in the first experiment, were validated in the second experiment, and across the experiments they exhibited a high classification performance.

“EEG is relatively inexpensive compared to many other neural imaging methods like magnetic resonance imaging and has a long history in vision research. Many tertiary eye care centers are already equipped with EEG systems, so the biomarkers are cost-effective”, says Dr. Suddha Sourav, first author of the study, “The two distinct groups of cataract reversal populations have often been lumped together as pediatric or infantile cataracts in many previous studies, which bear the risk of highly distorted or even incorrect results in clinical, epidemiological, and basic research. We think that the biomarkers could be used as an additional information source for better distinction between congenital and developmental etiologies.”

Dr. Ramesh Kekunnaya, Head of the Jasti V Ramanamma Children’s Eye Care Centre at the L V Prasad Eye Institute and co-author of the study, adds, “The identified EEG biomarkers could progress treatment and rehabilitation procedures for pediatric cataracts, improve future clinical outcome studies, and benefit epidemiological studies on the genetic origins of cataracts.”

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