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A Comprehensive Dataset of Pattern Electroretinograms for Ocular Electrophysiology Research: The PERG-IOBA Dataset

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Abstract

The pattern electroretinogram (PERG) is a valuable tool in ophthalmic electrophysiology, offering a non-invasive and objective method to evaluate central retinal function. By measuring electrical activity in the macula and retinal ganglion cells, PERG provides essential quantitative insights, especially when distinguishing between macular and optic nerve diseases remains challenging. This dataset comprises 1354 transient PERG responses from 304 subjects in 336 records, representing a comprehensive collection of ocular electrophysiological data. The evaluations took place at the Institute of Applied Ophthalmobiology (IOBA) at the University of Valladolid, Spain, from 2003 to 2022. Detailed clinical information, including age, gender, and diagnoses, is provided in CSV format. Additionally, the dataset, which guarantees the presence of at least one PERG signal for each eye, incorporates visual acuity measurements in logMar scale, facilitating assessments of vision quality. Addressing a significant gap in ocular electrophysiological signal

repositories, this dataset serves as a valuable resource for the advancement of ophthalmology research. Researchers can explore a wide range of eye-related conditions and diseases, leading to improved diagnostic techniques, treatment strategies, and a deeper understanding of ocular electrophysiology.

Background

The pattern electroretinogram (PERG) stands as a valuable ophthalmic electrophysiological test used to evaluate central retinal function [1]. By providing a non-invasive and objective measure of electrical activity in the macular and retinal ganglion cells, it offers crucial quantitative information for distinguishing between macular versus optical nerve diseases [2]. The PERG becomes particularly beneficial when the cause of vision dysfunction remains unclear even after standard clinical examination, allowing for more accurate diagnostic outcomes.

PERG signals are elicited through the presentation of repeating patterns to the eye. These patterns typically involve alternating black and white stimuli, specifically designed to stimulate the macular region of the retina. As the retina is exposed to these visual patterns, a cascade of electrical responses are generated in its layers. These responses are then captured and recorded through specialized electrodes placed on the cornea or the skin around the eye. The precision and reproducibility of PERG measurements make them an invaluable tool in ophthalmic electrophysiology, providing critical information that contributes to our understanding of the visual system.

To further our knowledge in this realm, we have created a novel dataset featuring transient PERG responses from human subjects who were evaluated at the Institute of Applied Ophthalmobiology (IOBA) of the University of Valladolid in Spain. The IOBA is a research institute primarily focused on ophthalmology and eye-related studies. As part of the University of Valladolid, the IOBA plays an important role in promoting synergies between academic research and practical clinical applications. Beyond its research efforts, the institute extends its services to clinical practice, thereby facilitating the seamless translation of research insights into tangible patient care.

Given the scarcity of ocular electrophysiological signal repositories, this comprehensive dataset holds valuable information that could contribute to significant advancements in ophthalmology research. Its availability creates new opportunities for studying various eye-related conditions and diseases, paving the way for enhanced diagnostic methods, treatment strategies, and a deeper understanding of ocular electrophysiology.

Methods

Participants

The dataset comprises information collected from 304 subjects enrolled at IOBA, a University of Valladolid-affiliated institution in Spain. The data collection spanned an extensive period, starting from 2003 and continuing until 2022. During this extended timeframe, 23 individuals had multiple visits: 19 individuals had two visits each, 1 individual had three, another had four visits and two subjects had five visits each. Out of the total number of participants, 155 were female, and the age range was from 4 to 86 with a mean of 37.1 ± 18.3 years. As a part of the routine clinical evaluation, all subjects underwent diagnosis by ophthalmology specialists. Out of the total number of participants, 100 subjects showed no eye-related medical conditions and were classified as normal.

Data Acquisition

All PERG signals were recorded by highly trained technicians using the computerized Optoelectronic Stimulator Vision Monitor MonPack 120 (Metrovision, Pérenchies, France), strictly adhering to the International Society for Clinical Electrophysiology of Vision (ISCEV) guidelines [3]. For each subject, a minimum of two signals were recorded - one for each eye.

During the PERG test, the subject is exposed to a low-contrast, black-and-white reversing checkerboard pattern, stimulating the retina at a frequency range of 1-2 Hz. The electrical responses from the retina are then recorded as the patient views the stimulating pattern.

For optimal data accuracy, a higher sampling rate of 1700Hz was employed during PERG recording, with each signal captured for a duration of 150 milliseconds and 255 equally spaced observations per signal. These signals are then carefully amplified and filtered to minimize any noise and artifacts that may be present.

To further enhance the quality of the data, multiple trials of the PERG are recorded and averaged together, each trial corresponding to a single presentation of the visual stimulus. This averaging process improves the signal-to-noise ratio.

The averaged PERG signal typically exhibits distinctive wave components, including N35 (a negative wave around 35 milliseconds), P50 (a positive wave around 50 milliseconds), and N95 (a larger negative wave around 95 milliseconds). For a visual reference, the included file typical_PERG.png illustrates the characteristic standard PERG waveform.

Data Description

The dataset comprises a total of 336 records, with each record corresponding to one visit, and encompasses 1354 PERG signals. Each record is assigned a unique four-digit identifier. The record identification has been custom-designed exclusively for this collection and is entirely independent of any information available in the participants' medical records.

The data is available in CSV (comma-separated-value) format, accessible from the \csv folder. All CSV records include the "time" column that has been date-shifted to de-indentify participants. The time is encoded as *YYYY-MM-DD hh:mm:ss.ms*. The CSV records consist of a variable number of PERG signals, ranging from 2 to 10, measured in microvolts. Each record within the dataset ensures the presence of at least one PERG signal for each eye, denoted by RE_1 for the right eye and LE_1 for the left eye. To accommodate cases where the test is repeated during the same visit, additional channels labeled RE_2, RE_3, and so forth, along with LE_2, LE_3, and so on, are included to encompass multiple signals collected for each eye. Moreover, to provide temporal information for the repeated tests, columns TIME_2, TIME_3, and so on, are added to the CSV records whenever applicable.

Additionally, the \csv folder houses the file participants_info.csv, which details the clinical and demographic information. This information includes the following key attributes for each record,

- <id_record>: A unique four-digit identifier.
- <date>: Date when the record was registered, offering a chronological reference point, encoded as YYY-MM-DD. Note that dates have been intentionally date-shifted randomly to preserve the sequence and time period duration.
- <age>: The subject's age in years at the time of the record.
- <sex>: The subject's gender, which can be "male" or "female".
- <diagnosis1-3>: These fields are used to record up to three different diagnoses or medical conditions that the subject may have.
- <va_re>: Visual acuity for the right eye, measured on logMar (logarithm of the minimum angle of resolution) scale. A logMAR value of 0 denotes "normal" vision, while values above 0 indicate a decrease in visual acuity. Conversely, negative logMAR values indicate better-than-normal visual acuity. Missing values are marked as "NA" to indicate the absence of that particular measurement.
- <va_le>: In a similar vein, this field is designated for recording visual acuity for the left eye, also measured on the logMAR scale. It follows the same principles of interpretation as mentioned for the right eye.

- <unilateral>: In cases where a medical condition affects only one side, this field specifies the involved eye, often marked as "RE" for the right eye or "LE" for the left eye.
- <rep_record>: This field is used to indicate whether the record corresponds to a follow-up visit. If it's a follow-up visit, it's marked with "id:id_record", where "id_record" is the identifier of the previous or posterior record being followed up.
- <comments>: This field accommodates additional insights or noteworthy information concerning the record.

Usage Notes

The comprehensive and high-quality nature of this dataset is very promising for the scientific community, as publicly accessible repositories containing this type of information are so far lacking. As an example of its utility, a total of 153 signals from 69 individuals without ocular pathology have already been utilized to validate new physiologically plausible statistical models for the analysis and prediction of PERG signals using the innovative Frequency Modulated Möbius (FMM) approach [4].

The implications of such an extensive and well-curated dataset are far-reaching. It grants researchers and scientists unparalleled access to a broad spectrum of PERG data, fostering the ability to embark on in-depth studies, discern emerging trends, and gain deep insights into the complexities of the visual system. These insights have the potential to substantially improve the comprehension of various eye disorders and conditions, including but not limited to optic neuropathies, retinal disorders, among others. They offer valuable knowledge regarding the progression of these conditions and can potentially contribute to the development of innovative treatments. Moreover, making this dataset accessible to a broader scientific audience not only fosters collaboration but also propels advancements within the field of ophthalmology. Additionally, it serves as an invaluable resource for validating research findings and refining methodological approaches.

No custom code was generated for the collection of the data.

Ethics

The data were collected during clinical activity and compiled for a specific project approved by the IOBA research commission (approval 2021/47) focused on the automated analysis of electrical signals obtained through ocular electrophysiology tests. The rigorous approval process ensures strict adherence to ethical and research standards. All patients were informed about the potential use of their data for

research purposes at the time of conducting ocular electrophysiological tests, ensuring compliance with general data protection regulations for informed consent. All protected health information has been meticulously removed from the dataset to guarantee the confidentiality and privacy of the subjects involved. Additionally, data collection dates have been randomly date-shifted to maintain the sequence and the duration of time periods.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

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```
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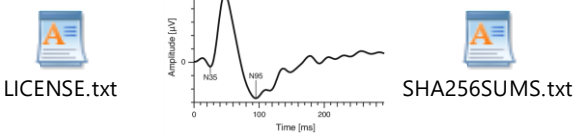

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