Zhou, Wei, "The Supervised Matching Pursuit (SMP) Method and its Application in Electroretinogram (ERG) Analysis"

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The multifocal electroretinogram (mfERG), recorded non-invasively from the cornea, represents local electrical responses of retinal cells to simultaneous light stimulation of many small regions of the retina. It is a useful tool for assessing retinal function. A transient oscillatory component of the mfERG, called the Oscillatory Potential (OP), can be affected by diseases, such as glaucoma and diabetic retinopathy, which affect inner retina. The exact cellular origins of OPs are currently unknown. Using the Matching Pursuit (MP) method, two major OP subtypes, the Fast and Slow OP, were isolated from the mfERG of monkeys, whose retinas are similar to those of humans. In control animals, the Fast and Slow OP evidenced different time-frequency characteristics. Through experiments, in which inner retinal activity was reduced or eliminated by pharmacological agents or experimental glaucoma, the Fast OP generators were revealed to be the spiking activity of ganglion cells and their axons, as well as the non-spiking activity of amacrine cells, while the Slow OP apparently originated from the non-spiking activity of amacrine cells and more distal cells.

The MP method, with its redundant function dictionary, is laborious, and mismatches caused by atoms representing high-energy structures may lead to errors. To improve efficiency and accuracy, the Supervised Matching Pursuit (SMP) method was developed. The SMP method improved efficiency by utilizing a training data set to reduce the size of the function dictionary. The SMP method also improved accuracy by directly extracting the structures of interest (e.g., the OPs) from the mfERG. For simulated mfERGs, the SMP method was more efficient and accurate than the MP method in extracting the Fast and Slow OP, if the size of the training data set and function dictionary was relatively large. The SMP method also provided more stable results and was more sensitive to spatial variations of the Fast OPs. In the study of experimental glaucoma, the SMP method revealed changes in the time-frequency characteristics of the Fast OP that were not observed using other methods (MP or band-

pass filtering). In addition, the energy of the Fast OP demonstrated potential utility in detecting early glaucoma.