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Unsupervised Machine Learning with Independent Component Analysis Identifies Areas of Progression in Glaucomatous Visual Fields

P.A. Sample[1,A], Z. Zhang[1,B], J. Pascual[1,A], K. Chan[2], C. Boden[1,A], J. Hao[1,B], T.–W. Lee[1,B], R.N. Weinreb[1,A], T. Sejnowski[1,B] and M. Goldbaum[1,C]

[A] Hamilton Glaucoma Center, [B] Institute for Neural Computation, [C] Ophtalmic Informatics Laboratory, [1] University of CA San Diego, La Jolla, CA
[2] SortMax, Inc., La Jolla, CA

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Abstract

Purpose: To determine if Independent Component Analysis (ICA), a form of unsupervised machine learning, can be used to identify areas of progression in standard visual fields.

Methods: We have previously shown that the unsupervised machine learning classifier, ICA, can separate normal fields from fields with 6 different areas of visual field loss related to GON along maximally independent axes (ARVO abstract) 43:#2178, S87, 2002). Axis areas of loss affected: 1) both hemifields, 2) superior peripheral, 3) temporal wedge 4) superior horizontal or arcuate, 5) nasal, 6) inferior hemifield. An independent group of 191 patient eyes (OHT = 50; Suspects = 63; Glaucoma = 78) with 5 or more standard visual fields followed for a mean + sd of 6.24 + 2.65 years with 8.11 + 2.42 visual fields were evaluated for this study using ICA. Each had a series of fields with each field entered independently and placed along each axis based on the standard deviation from the mean of the original group of eyes with GON. This allows change in one area of the visual field (along one axis) to be assessed relative to what is happening in other areas of that same field (no change along other axes). Progression was based on a slope falling outside the 95% confidence limits of all slopes with at least two axes not showing such a deviation in a given individual's series of fields covering at least 3 years.

Results: 31 of 191 eyes progressed by this definition. Of the 31, 20 had glaucoma, 8 were suspects, and 3 were OHTs. Areas of progression were consistent with axis descriptions formulated in the previous study for 93% of the determinations.

Conclusions: Use of ICA to identify progression in eyes with glaucoma in one or more areas of the visual field while other areas remain stable may enable each individual eye to contribute to the determination of whether change is true progression as opposed to variability.

Keywords: visual fields • perimetry