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Multiple frog retinal ganglion cell recordings with a multi-electrode array

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Simultaneous multiple retinal ganglion cell recordings have been made successfully from peripheral primate retina using a 61 electrode array on a rigid mounting (Chichilnisky & Baylor, 1999). Our concern has been to manufacture an array on a flexible mounting which can assume the contour of the structure from which recordings are to be made. On a flexible layer of polyimide 120 μm thick, a layer of titanium 30 nm deep followed by a layer of gold 150 nm deep are deposited. These are etched by photolithography to produce conducting tracks 50 μm wide which are then insulated with a 1.5-2.0 μm layer of polyimide. The tracks lead to eight 50 μm diameter gold electrodes, positioned 50 μm apart in a 2 X 4 array, which are then coated with platinum. The electrode impedances which depend on the platinum deposition are within the range 6-40 kΩ. Under development is an hexagonal close-packed array consisting of 61 electrodes of diameter 5-10 μm contained within an area of 0.17 mm^2 connected to tracks 10 μm wide, with the eventual aim of increasing this to several hundreds of electrodes within an area of several mm^2. The central ends of the gold tracks have connection points which are connected to a preamplifier which has amplification X1000, input impedance 10^{12} Ω, bandwidth 3Hz-8kHz (-3dB) and incorporates a programmable 50 Hz notch filter. The outputs from the preamplifier are fed into a 100 channel National Instruments PCI-6071E data acquisition board which captures data at 10 kHz and displays and stores it under the WinWCP version 3.3.3 programme (Dempster, 2003).The preparation on which the array is being tested is the frog retina *in situ*. This has, at its inner surface, retinal ganglion cells of some 10 μm diameter arranged in a layer of one or two cells deep, which provide a suitable model for the small P ganglion cells of primate/human retina. After induction of anaesthesia by immersion in MS 222 solution, the brain and spinal cord of the frog is pithed. Then the eyelids are resected, cornea removed, aqueous humour absorbed, iris retracted with strips of filter paper and the lens with the vitreous body attached lifted out to expose the retina. The array is advanced into the eyecup, the retina detached from the underlying pigment epithelium and laid over the recording electrodes, rather like a folded pancake. Concurrently, recordings are also made from the vitreal surface of the retina with a silver wire electrode of diameter 100 μm: this allows recording of the electroretinogram with superimposed multi-unit activity to verify the viability of the preparation. Recordings are made in response to pulses of light of variable intensity and duration from a green light-emitting diode which is triggered in synchrony with the sweep of the WinWCP programme. Provided the retina is kept moist, recordings can be made for in excess of 3 h. During this time, it is feasible to change the position of the retina in order to sample a new population of retinal ganglion cells. In our demonstration, the array is immersed in 0.7% saline solution and stimulated with 1 kHz square wave of 1 mV amplitude delivered from a silver wire electrode in order to demonstrate the recordings made from electrode array and data acquisition system.

Chichilnisky EJ & Baylor DA (1999) *Nature Neurosci* **2,** 889-893.

Dempster J (2003) http://innovol.sibs.strath.ac.uk/physpharm/software/winwcp.shtml

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Where applicable, the experiments described here conform with Physiological Society ethical requirements.