Medical Research Council
Neurological Prostheses Unit:
London 1968-1992

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How (not) to communicate new scientific information:
a memoir of the famous Brindley lecture
Laurence Klotz

Giles Brindley and the patient with the first visual prosthesis
# MRC Neurological Prostheses Unit: Staff

**Director**  
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P. E. K. Donaldson
N. de N. Donaldson
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**Engineer**  
P. E. K. Donaldson
N. de N. Donaldson

**Neurologist**  
D. N. Rushton

**Senior Research Officer**  
J. D. Cooper

**Research Officer**  
T. A. Perkins

**Technical Staff**  
N. Chaffey
J. Jackson
E. Sayer
| Artificial visual pathway                  | occipital cortex          |
| Implantable bladder and sphincter controller | S3 –S4                  |
| Artificial motor pathway                  |                          |
| Tactile-auditory substitution device      | vibrating rings on fingers |
| Artificial auditory pathway               | auditory cortex          |
| Improved carotid sinus stimulator         | hypertension treatment   |

“Plans for the future”
Prevent muscle wasting after denervation by stimulation
Artificial sphincter stress incontinence
<table>
<thead>
<tr>
<th>Artificial visual pathway</th>
<th>occipital cortex</th>
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<td>epilepsy</td>
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“Plans for the future”

<table>
<thead>
<tr>
<th>Posterior column stimulator</th>
<th>multiple sclerosis</th>
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<tbody>
<tr>
<td>Deep brain stimulation (“stereotaxic”)</td>
<td>auditory prosthesis</td>
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<tr>
<td></td>
<td>obesity or anorexia nervosa</td>
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<td></td>
<td>pain relief</td>
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<table>
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<th>Artificial lens</th>
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<td>Artificial sphincter</td>
<td>stress incontinence</td>
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<td>Intracranial stimulation</td>
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<td>Intracranial pressure sensor</td>
<td></td>
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<tr>
<td>Pancreatic nerve stimulator</td>
<td>diabetes</td>
</tr>
<tr>
<td>Sexual &amp; reproductive disorders</td>
<td>SCI</td>
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Quinquennial Report, 1987

Artificial visual pathway occipital cortex
Sacral Anterior Root Stimulator
Conditional Pudendal Nerve Stimulator treat detrusor instability
Improved artificial sphincter
Artificial motor pathway
Cochlear Prosthesis
Fertility implant Semen collection Cannula in vas deferens
Hypogastric plexus stimulator for ejaculation
Non-phrenic breathing implant
Deep brain stimulator Tremor after MS
Rapid signaller after high tetraplegia motor cortex
Gracilis sling Faecal incontinence
ditto
Artificial anal sphincter ditto
Artificial pubo-rectalis sling ditto
Artificial Visual Pathway
80 separate receivers.
Prior tests on 14 baboons

“Our findings strongly suggest that it will be possible, by improving our prototype, to make a prosthesis that will permit blind patients not only to avoid obstacles when walking, but to read print or handwriting, …”

Fig. 1. The circuit (from Brindley, 1964) of a radio receiver from the first prototype visual prosthesis implant. $L$ is 3.7 or 9.1$\mu$H, $C_4$ is 75$pF$, $C_3$ is 1$\mu F$, and $R$ is 8.2$\Omega$.

The sensations produced by electrical stimulation of the visual cortex
Brindley & Lewin, J Physiol, 196, 479-493. 1968
Ceramic packages (Newmarket Transistors Ltd)

Baboon implant

Test Tank

Some pictures from 1970

The lab

Work-station
Mr Browning, 1972
76-channel visual prosthesis

“ – came to see us. He would like to join us his attitude to work is a bit different from ours – he expects of technician back-up. But this may be that he has never had any … I hope we will be able to wean him away from this view. In his favour one must concede that he is only voicing the usual view. It is Giles and I, with our Cambridge background, who are the eccentrics.”

Miss Bonnett, 1982

76-channel visual prosthesis
(removed because of infection after one year)

Understanding Encapsulation

- adhesive
- life
- adherend
- corrosion
- products
- cleaning
- casting
- without
- voids
- design
- avoiding
- voids
- during cure

- implant to alleviate facial pain after 10 years of daily use
- ‘implant’ grade (biocompatible)
Artificial Motor Pathway
Artificial motor pathway (Refs 1, 6, 13, 14, 21, 24).

The aim of this project is to give paraplegic patients voluntary control over the muscles of their legs. The devices developed may perhaps also be applied to the arm in hemiplegic patients, but this seems less likely to be successful. No artificial proprioceptive or tactile pathway is at present under development; the project rests on the hypothesis that, in the legs, motor control without proprioceptive or tactile feedback can be useful. Observations on patients with tabes dorsalis support this hypothesis but do not suffice to establish it as a fact.

The driving signals for the artificial motor pathway will almost certainly be taken from the leg area of the motor cortex. Experiments on baboons show that suitable electrical signals, recordable with subdurally or extradurally implanted electrodes, appear in the motor cortex a few tens of milliseconds before a voluntary movement begins. The region from which they can be recorded coincides approximately with the region that on stimulation causes a similar movement. Baboons that have been trained to make specific leg movements while neurologically intact continue, in the training situation, to generate the corresponding motor cortical signals during the first few days after they have been made paraplegic. Whether they can continue to do this for months or years remains to be determined.

The neural structures to be stimulated by artificial motor pathway will be either anterior roots, split in continuity, or the nerve branches to individual muscles. The latter possibility has the advantage of allowing a wider range of movements, but the disadvantages that sensory fibres also will be stimulated and that cables must be run past joints, with risk of fatigue fracture.

Our recent work on the artificial motor pathway has been on optimizing the electrical filters for discriminating voluntary movement signal of the motor cortex from other cortical activity, and on improving the reliability of implantable electrical devices that will perform the
Artificial Motor Pathway

Craggs, Advances in Neurology, 1975, 10, 91-101

• Signals must be reliably detectable from background noise
• Stable over a long period of time
• Well localised
• Survive a spinal transection

1/2 mm diameter cortical electrodes on 2 mm pitch

juice reward

mapped voluntary movement signals (MVMS)

EMG signals lever signals

could not discriminate flexion and extension

hip area EMG hamstrings red light cue

foot area EMG tibialis green light cue

cortical signals stable for 20 days after spinal transection
Rushton, Perkins, Donaldson

Two channels without ICs and without an hermetic enclosure

transmitter modulation
Output 1
Output 2


**The Ion Squeezer**

*Fig. 1* Electrolytic resistor/switch. The base and the lid are of alumina ceramic. Walls, tubes and diaphragm are of silicone rubber. The sinuous structures are the Pt/Ir electrodes, made by pulling out the helical conductors from the connecting Cooper cables.
Main Engineering Science Achievement
Theory and practice of encapsulation
Radio-frequency inductive links
Safe use of Pt electrodes
Optimised design of inductively-powered implants

MRC NPU Publications
1971 - 74  21
1974 - 78  27
1978 - 82  47
1982 - 87  71
1987 - 92  86

The Flowsecure™ Artificial Urinary Sphincter
Inventor Michael Craggs

Conditional occlusion of the urethra to control stress urinary incontinence
Brindley - A few references to show the range


The absence of position sense in the human eye Brindley & Merton, J Physiol, 153,127-130, 1960

La fisiologica de la vision de los colores Brindley, Ciencia e Investigacion, 17,453-464, 1961

How does an animal that is dropped in a non-upright posture know the angle through which it has to turn in the air so that its feet point to the ground? Brindley, J Physiol, 180,20-21P, 1965

The sensations produced by electrical stimulation of the visual cortex Brindley & Lewin, J Physiol, 196, 479-493. 1968


A substitute for hermeticity in implantable pressure sensors Brindley, J Physiol, 272,7-8P, 1977


Sacral anterior root stimulators for bladder control in paraplegia Brindley, Polkey & Rusthton, Paraplegia, 20, 365-381, 1982

Technique for very long term monitoring of intracranial pressure Brindley, Polkey & Cooper, MBEC, 21, 460-464, 1983

Hypogastric plexus stimulators for obtaining semen from paraplegic men Brindley, Sauerwein & Hendry, Brit J Urology, 64, 72-77, 1989
Publications on musical acoustics and musical instrument technology


Achievements in veteran athletics

Holder of the British over-55 record for 3000m steeplechase 1982-90 and the over-60 record for the 3000m and 2000m in steeplechase since 1986.

Holder of the British and European over-65 records for 2000m steeplechase since 1991.

British over-55 champion at 3000m steeplechase in 1982 and 1983.

British over-60 champion at 10,000m (track) and 10 miles (road) in 1986.

British over-60 champion at 3000m steeplechase in 1986 and 1987.

British over-60 champion at cross-country in 1987.

British over-65 champion at 5000m (track) in 1991.

Bronze medal in the European Veterans Championships at steeplechase in 1982 (Strasbourg) and 1986 (Malmö).

Bronze medal in the World Veterans Championships (Melbourne) in 1987 at 4 x 400m relay.

Bronze medal in the World Veterans Championships (Turku) in 1991 at 4 x 400m relay.

Silver medals in the World Veterans Championships (Turku) in 1991 at 2000m steeplechase and 800m.
A life’s work of such significance to those who have benefitted and an inspiration to colleagues, has not gone unnoticed. Medicine and surgical technique have been advanced by your dedication in providing practical treatments in the restoration of effective urinary voiding, urinary incontinence, erectile potency, and male fertility. Research thinking and bio-engineering technology has been advanced by the wide range of methods that you have used: electrical stimulation, stimulator implants, drug treatments, intracavernosal injection, mechanical and hydraulic implants, and self-sealing capsules.