

**THE BIONICS INSTITUTE
ANIMAL RESEARCH & ETHICS COMMITTEE**



One (1) original of the complete final report (plus copies of publications) should be forwarded to

The Secretary, Animal Research & Ethics Committee

FINAL REPORT

1. DETAILS

Project Title	Focussed current stimulation in the cochlea
Project Number	12/250AB
Principal Investigator	Dr James Fallon
Nominated Contact (if applicable)	
Date Original Approval Received	28 th February 2012

2. ANIMAL USE TABLE

	Total		Total
Initial Animals Approved :		Additional Animals Approved:	
Species 1 – Cat	16	Species 1 -	
Species 2 – Guinea Pig	32	Species 2 – Guinea Pig	16
Total Animals Used:			
Species 1 - Cat	13		
Species 2 – Guinea Pig	30		

3. PROJECT PERSONNEL (All persons to have worked on project at any time)

RESEARCHER NAME	POSITION HELD
Dr James Fallon	Senior Research Fellow
Professor Rob Shepherd	Director
Dr. Andrew Wise	Senior Research Fellow
Prof Dexter Irvine	Prof Research Advisor
Dr. Sam Irving	Research Fellow
Ms. Alison Neil	Research Assistant
Ms. Amy Morley	Research Assistant
Ms. Nicole Critch	Technical Officer
Ms. Melanie Gault	International Engineering student
Ms Michelle McPhedran	Research Assistant
Mr Thomas Spencer	Research Assistant
Mr Damian Robb	Research Assistant
Ms Emma Johnson	Research Assistant
Dr Philipp Senn	Research Assistant
Ms Shefin George	Research Assistant

4. PLEASE OUTLINE HOW THE PROJECT AIMS WERE ACHIEVED:

The project aimed to evaluate the efficacy of phased array stimulation (PAS) to provide more precise spatial and temporal resolution in cochlear implants in comparison to traditional monopolar (MP) and bipolar (BP) stimulation in controlled animal studies. The experiments were done in guinea pigs and cats of acute, short term and long term deafness. Guinea pigs were in cohorts of 0,1 and 2 months of deafness while cats were in cohorts of 0 and 6 months of deafness. Following assessment of hearing status using auditory brain responses and implantation of the electrode array into the deafened cochlea, each animal had an acute terminal experiment to record neural excitation across the inferior colliculus (IC).

The efficacy of PAS was evaluated by examining whether:

- H1. PAS produces more spatially restricted patterns of neural excitation than bipolar or monopolar stimulation;
- H2. PAS increases the number of temporally independent channels compared with bipolar and monopolar stimulation;
- H3. The advantages of PAS over bipolar and monopolar stimulation are maintained in cochleae with significant neural degeneration;
- H4. PAS efficacy is maintained where the electrode array is positioned distal to the auditory nerves;
- H5. PAS thresholds are negatively correlated with local neural survival;
- H6. PAS does not result in ectopic activation of non-auditory neurones.

Cohort	Species	# animal per group	# animals allocated	Duration of deafness	Hypotheses tested
1	G pig	32	22	0	H1, H2, H3, H5, H6
2	G pig	8	4	1 month	H3, H1, H2, H5, H6
3	G pig	8	4	2 months	H3, H1, H2, H5, H6
4	Cat	8	6	0	H4, H1, H2, H5, H6
5	Cat	8	7	6 months	H4, H3, H2, H1, H5, H6

5. PLEASE DETAIL PROJECT OUTCOMES (e.g. FURTHER RESEARCH PUBLICATIONS):

Preliminary results from this project have been presented at the Australasian Auditory Neuroscience Workshop 2013 & 2014 and published in the Journal of Neural Engineering. An additional two manuscript are current under preparation / review. The experiments showed that PAS results in more restricted supra-threshold stimulation than MP stimulation (Figure 1), in both acutely and long-term deafened animals. However, the improved selectivity comes as the cost of increased thresholds.

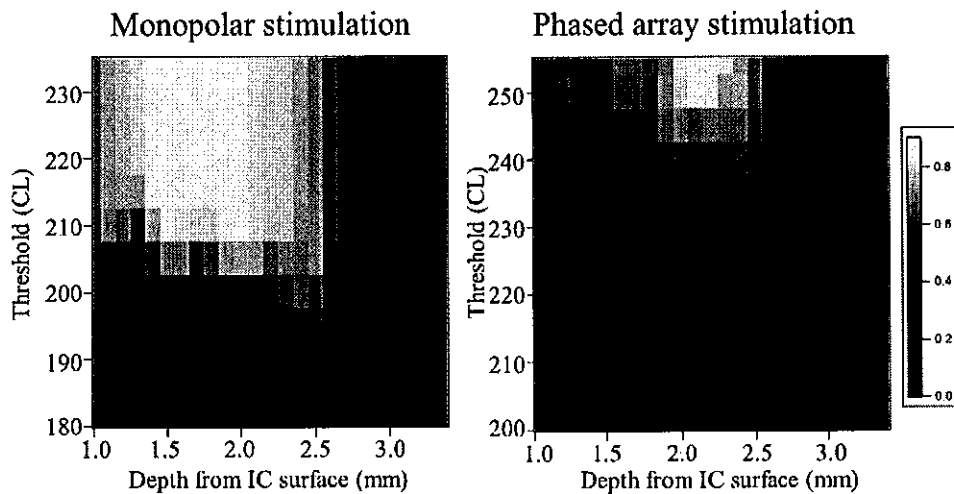


Figure 1. IC response images for MP and PAS at the centre electrode for acutely deafened guinea pig 12_368. The scale represents normalised spike probabilities.

Final Report Publication Listing

Please provide a detailed list of all publications arising from this study.

1. George, SS, Fallon, JB & Wise, AK. Evaluation of Focused Multipolar Stimulation for Cochlear Implants in an Animal Model. 3rd International Conference on Medical Bionics 2013. (Presentation)
2. George, SS, Fallon, J, Wise, A & Shepherd, R. Evaluation of Focused Multipolar Stimulation for Cochlear Implants in an animal model. SOBR 2013.
3. George, SS, Fallon, J, Wise, A & Shepherd, R. Evaluation of Focused Multipolar Stimulation for Cochlear Implants in an animal model. Biomed Link 2013.
4. George, SS, Fallon, JB, Wise, AK & Shepherd, RK. INVESTIGATING THE EFFECT OF FOCUSED MULTIPOLAR STIMULATION STRATEGY FOR COCHLEAR IMPLANTS. Australasian Auditory Neuroscience Workshop 2014. (Presentation)
5. George, S, Fallon, JB, Wise, AK, Shivdasani, MN & Shepherd, RK. Evaluation of Phased Array Current-Focussing Strategy in Cochlear Implants using Animal Models. Australasian Auditory Neuroscience Workshop 2013. (Presentation)
6. George, SS, Wise, AK, Shivdasani, MN, Shepherd, RK & Fallon, JB. 2014. Evaluation of focused multipolar stimulation for cochlear implants in acutely deafened cats. Journal of Neural Engineering 11, 065003.
7. George, S, Shepherd, RK, Wise, AK, Shivdasani, MN and Fallon, JB. Focused Multipolar Stimulation for Improved Performance of Cochlear Implants: Preclinical Studies. Australasian Auditory Neuroscience Workshop, Dec 2014. (Presentation)

6. RESEARCH CONCLUSIONS: (May be attached)

PAS offers a potential way to improve hearing fidelity for the next generation of cochlear implant patients, although issues surrounding the increased threshold still need to be addressed. A study to test the chronic safety of this type of stimulation has been funded by the ARC and is currently underway.

PRINCIPAL INVESTIGATOR: *James Fallon*

DATE: 27/01/2015