

**USE OF AN ENRICHED ENVIRONMENT POST-STROKE:  
TRANSLATING FROM BENCH TO BEDSIDE**

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I Heidi Janssen hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968.

I Heidi Janssen hereby certify that this thesis is submitted in the form of a series of published papers of which I am a joint author. I have included as part of the thesis a written statement from each co-author; and endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to the joint publications.

In addition, ethical approval from the University of Newcastle Human Ethics Committee was granted for the clinical study presented in this thesis. Participants were required to read a participant information document and informed consent was gained prior to data collection.

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# **PUBLICATIONS, PRESENTATIONS AND AWARDS**

## **PEER REVIEWED PUBLICATIONS INCLUDED IN THIS THESIS**

**Janssen H**, Bernhardt J, Collier JM, Sena ES, McElduff P, Attia J, Pollack M, Howells DW, Nilsson M, Calford MB, Spratt NJ. An enriched environment improves sensorimotor function post-ischemic stroke. *Neurorehabil Neural Repair*. 2010; 24:802-813. **[Publication 1]**

**Janssen H**, Ada L, Karayanidis F, Drysdale K, McElduff P, Pollack M, White J, Nilsson M, Bernhardt J, Spratt NJ. Translating the use of an enriched environment poststroke from bench to bedside: study design and protocol used to test the feasibility of environmental enrichment on stroke patients in rehabilitation. *Int J Stroke*. 2012; 7(6):521-526. **[Publication 2]**

**Janssen H**, Ada L, McElduff P, Pollack M, Nilsson M, Bernhardt J, Spratt NJ. Physical, cognitive and social activity levels of stroke patients undergoing rehabilitation in a mixed rehabilitation unit. *Clin Rehabil*. 28 Nov 2012; Epub ahead of print. **[Publication 3]**

**Janssen H**, Ada L, Bernhardt J, McElduff P, Pollack M, Nilsson M, Spratt NJ. An enriched environment increases activity in stroke patients undergoing rehabilitation in a mixed rehabilitation unit: A pilot non-randomised controlled trial. *Disabil Rehabil*. 30 Apr 2013; Epub ahead of print. **[Publication 4]**

## **OTHER PUBLICATIONS AND PRESENTATIONS ARISING FROM THIS THESIS**

Parts of the work presented in this thesis have been published and/or presented in the following forums:

### **PUBLISHED ABSTRACTS**

**Janssen H.** While the cat's away, the mice will play: Physically, cognitively and socially (which will enhance their survival on its return!). *Int J Stroke*. 2009; Conference: Combined Meeting of the 6th Asia Pacific Conference Against Stroke and the 20th Stroke Society of Australasia Cairns, QLD Australia. Conference Start: 20090906 Conference End: 20090910. Conference Publication: (var.pageings). 4:19. (Keynote Speaker).

**Janssen H,** Speare S, Spratt NJ, Bernhardt J. Systematic review and meta-analysis of the efficacy of training in animal models of stroke. Can it reveal the optimal dose and time for commencement? *Int J Stroke*. 2010; Conference: 21st Annual Scientific Meeting of the Stroke Society of Australasia Melbourne, VIC Australia. Conference Start: 20100901 Conference End: 20100903. Conference Publication: (var.pageings). 5:28. (Oral Presentation).

**Janssen H**, Ada L, Bernhardt J, Karayanidis F, Drysdale K, McElduff P, Pollack M, Nilsson M, Spratt NJ. The use of an Enriched Environment post-stroke: Translating from bench to bedside. WCNR 2012 Oral Abstracts. *Neurorehabil Neural Repair*. 2012; 26: 654-694.

Bernhardt J, **Janssen H**, Ada L, McElduff P, Pollack M, Spratt NJ. Exposure to an enriched environment increases post-stroke activity and decreases time spent alone European Stroke Conference 21st Conference, Abstract E-Book. *Cerebrovasc Dis* 2012; 33(suppl 2):1-944.

**Janssen H**, Ada L, McElduff P, Pollack M, Nilsson M, Bernhardt J, Spratt NJ. An enriched environment increases activity in stroke patients undergoing rehabilitation in a mixed rehabilitation unit: A controlled trial. Stroke 2012: Combined 23rd Annual Scientific Meeting of the Stroke Society of Australia and 8<sup>th</sup> Smart Strokes Australasian Nursing and Allied Health Stroke Conference. *Int J Stroke*. 2012;7 (suppl 1): 1-69.

Alborough K, White J, **Janssen H**, Spratt NJ, Jordan L, Pollack M. Exploring staff experience of participation in an enriched environment: A qualitative study. Combined 23rd Annual Scientific Meeting of the Stroke Society of Australia and 8th Smart Strokes Australasian Nursing and Allied Health Stroke Conference. *Int J Stroke*. 2012;7 (suppl 1): 1-69.

Bartley E, White J, **Janssen H**, Spratt NJ. Exploring stroke survivor's experience of participation in an enriched environment: A qualitative study. Combined 23rd Annual Scientific Meeting of the Stroke Society of Australia and 8th Smart Strokes Australasian Nursing and Allied Health Stroke Conference. *Int J Stroke*. 2012;7 (suppl 1): 1-69.

## **ADDITIONAL CONFERENCE PRESENTATIONS**

**Janssen H**, Ada L, Bernhardt J, McElduff P, Pollack M, Spratt NJ. Is a stroke patient's time in rehabilitation enriching? Quantifying physical, cognitive and social activity levels post-stroke. Conference: 7<sup>th</sup> Smart Strokes Australasian Nursing and Allied Health Stroke Conference. Gold Coast QLD, Australia, August 2011 (Oral Presentation).

**Janssen H**, Ada L, Bernhardt J, McElduff P, Pollack M, Spratt NJ. Levels of physical, cognitive and social activity are low and stable during a two week period of stroke rehabilitation. Conference: Australian Physiotherapy Association. Brisbane, QLD Australia, October 2011 (Oral Presentation).

## CONFERENCE WORKSHOPS AND SYMPOSIUMS

**Janssen H** & Stacey S.

Workshop title: Enriching the stroke recovery environment. What's this all about?

Conference: 6<sup>th</sup> Smart Strokes Nursing and Allied Health Stroke Conference. Terrigal, NSW Australia, August 2010.

Nilsson M, Bernhardt J, **Janssen H**, Pekny M.

Symposium title: Neuroscience bench to bedside stroke recovery

Conference: Stroke 2012: Combined 23rd Annual Scientific Meeting of the Stroke Society of Australia and 8<sup>th</sup> Smart Strokes Australasian Nursing and Allied Health Stroke Conference. Sydney, NSW Australia, August 2012.

## CONFERENCE PRESENTATIONS - POSTER

*e-Poster* (placed in top 100 of over 3000 abstracts submitted)

**Janssen H**, Ada L, McElduff P, Pollack M, Nilsson M, Bernhardt J, Spratt NJ. An enriched environment increases activity in stroke patients undergoing rehabilitation in a mixed rehabilitation unit: A controlled trial. Conference: European Stroke Conference. Lisbon, Portugal, May 2012.

## **AWARDS**

### ***Best Innovation / Implementation***

**Janssen H**, Ada L, McElduff P, Pollack M, Nilsson M, Bernhardt J, Spratt NJ. An enriched environment increases post-stroke activity and decreases time spent alone. Conference: Combined 22<sup>nd</sup> Annual Scientific Meeting of the Stroke Society of Australia and 8<sup>th</sup> Smart Strokes Australasian Nursing and Allied Health Stroke Conference. Sydney, NSW Australia, August 2012.

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Alborough K, White J, **Janssen H**, Spratt NJ, Jordan L, Pollack M. Exploring staff experience of an ‘enriched environment’ within stroke rehabilitation: A qualitative sub-study. *Under review*.

Bartley E, White J, **Janssen H**, Spratt NJ. Exploring stroke survivor's experience of participation in an enriched environment: A qualitative study. *Under review*.

Buckley N, Karayanidis F, Drysdale K, **Janssen H**, Spratt NJ. The use of environmental enrichment to enhance patient rehabilitation post-stroke: A psychological perspective. Newcastle: School of Psychology, Faculty of Science and Information Technology, University of Newcastle; 2010 (Honours Project).

Hooke RM, Karayanidis F, Drysdale K, **Janssen H**, Spratt NJ. The use of an enriched environment to improve cognitive recovery post-stroke: A pilot study. Newcastle: School of Psychology, Faculty of Science and Information Technology, University of Newcastle; 2011 (Honours Project).

Raad S, Marquez J, **Janssen H**. The relationship between functional independence and physical activity during stroke rehabilitation. Newcastle: School of Health Sciences, Faculty of Health, University of Newcastle; 2011 (Honours Project).

## **OTHER PEER REVIEWED PUBLICATIONS COMPLETED DURING THE COURSE OF THIS PhD**

**Janssen H**, Speare S, Spratt NJ, Sena ES, Ada L, Hannan AJ, McElduff P, Bernhardt J. Exploring the Efficacy of Constraint in Animal Models of Stroke: Meta-analysis and Systematic Review of the Current Evidence. *Neurorehabil Neural Repair*. 2012; 27:3-12.

## **OTHER PUBLICATIONS AWAITING DECISIONS**

Egan KJ, **Janssen H**, Sena E, Bernhardt J, Longley L, Speare S, Howells DW, Spratt NJ, Macleod M, Mead GE. Exercise reduces infarct volume and facilitates neurobehavioural recovery: Results from a systematic review and meta-analysis of exercise in experimental models of focal ischemia. *Under review*.

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# ABSTRACT

Despite evidence linking higher levels of activity with better outcomes, stroke patients undergoing rehabilitation in hospital settings spend the majority of their waking hours inactive and alone. Environmental enrichment, through the use of equipment and organisation of the environment to facilitate physical, cognitive and social activity, is an intervention which has been used extensively in animal models of stroke. Results from these models have demonstrated the sensorimotor and cognitive benefits of recovering in an enriched environment, however there is conflicting data suggesting no benefit. The purpose of this PhD was to determine the efficacy of environmental enrichment in animal models of stroke, and then develop and pilot test a model of enrichment in stroke survivors.

Systematic meta-analytic methods were used to determine the efficacy of an enriched environment in animal models of stroke. Exposure to an enriched environment in animal models of stroke was associated with significantly better sensorimotor function and a trend towards better learning. Recovering in an enriched environment was also associated with a small but significant increase in lesion size (larger damaged area). However, the importance of this finding at an experimental level requires further investigation.

To explore the feasibility of translating this paradigm from the bench to the bedside, a model of environmental enrichment incorporating both communal and individual enrichment was developed for use with stroke patients in the clinical setting. Behavioural observation was used to evaluate its effect on stroke patient activity. Patients exposed to individual and communal environmental enrichment were more

likely to be active and were less likely to spend time ‘inactive and alone’ or sleeping than those recovering in a non-enriched rehabilitation unit.

This thesis outlines the research undertaken in the first known attempt to translate the use of a model of environmental enrichment from the laboratory into a clinical stroke rehabilitation setting. Evidence presented demonstrates that this model of environmental enrichment can increase activity levels of stroke patients. This preliminary research sets the foundations for further exploration of the efficacy of environmental enrichment on post-stroke function, mood and quality of life.