



## **Methodologies in Pain Management and Virtual Rehabilitation Research: Workshop Summary**

Tuesday 6<sup>th</sup> January 2009

A workshop organised by the IHR Quality of Life Network Leads:

Dr Gabor Barton ([G.J.Barton@ljmu.ac.uk](mailto:G.J.Barton@ljmu.ac.uk))

Dr Helen Poole ([H.M.Poole@ljmu.ac.uk](mailto:H.M.Poole@ljmu.ac.uk))

The recent IHR workshop at RISES (LJMU) provided an opportunity to showcase some of the expertise available locally in Liverpool. Those present were able to inform others on their ongoing research and discuss potential future collaborations related to Pain Management and Virtual Rehabilitation.

Below are summaries of the topics which were presented by individual speakers at the Workshop.

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### **Assessment of treatments for chronic pain**

*Dr Helen Poole ([h.m.poole@ljmu.ac.uk](mailto:h.m.poole@ljmu.ac.uk))*

*Liverpool John Moores University*

Helen presented a brief overview of recent collaborative projects completed in conjunction with clinicians at The Walton Centre for Neurology and Neurosurgery NHS Trust and Pain Research Institute, University of Liverpool. All relate to the use of outcome measures to assess the impact of existing and novel treatments

for chronic pain. A questionnaire to assess quality of life in neuropathic pain has been developed using patient centred methods (Poole, Murphy, Nurmikko) and its sensitivity is being tested in patients undergoing surgical and pharmacological interventions. A series of studies have investigated the psychometric properties of tools to evaluate depression in pain patients (Poole, Murphy, Bramwell). Current projects include: exploring the experience and impact of complex regional pain syndrome (CRPS) to inform development and testing of an integrated care pathway (Goebel, Poole, Murphy, Pope); analysis of retrospective data to identify psychosocial predictors of success to a pain management programme (Poole, Murphy, Nurmikko, Richardson) and psychological predictors of outcome to surgery for back pain (Paterson, Poole, Booker).

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## **Functional Magnetic Resonance Imaging (fMRI) of the brain in the assessment of chronic pain**

*Professor Turo Nurmikko ([tin@liverpool.ac.uk](mailto:tin@liverpool.ac.uk))*

*University of Liverpool & Walton Centre for Neurology and Neurosurgery*

Professor Turo Nurmikko has been evaluating changes in the brain in patients with chronic pain using functional MRI. In phantom limb pain, there is considerable cortical reorganisation present, which is reduced as phantom limb pain is controlled with mental imagery (Maclver). Patients with trigeminal nerve pain show altered somatotopy (Basu), and patients with disabling low back pain show evidence of lack of activation of the cerebrally initiated pain modulatory system (Lloyd). Current studies evaluate the role of prefrontal cortex in low back pain (Kelly) and nerve pain (Stancak); in the latter we use magnetoencephalography (MEG).

Current plans involve further use of these methods, with a possible addition of transcranial magnetic stimulation, in other pain conditions, both for pathophysiological investigations and therapeutic applications (Zaman).

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## **Real-time Human Brain Mapping: brain-training**

*Dr Arshad Zaman ([azaman@liverpool.ac.uk](mailto:azaman@liverpool.ac.uk))*

*Pain Research Institute and University of Liverpool*

Dr Arshad Zaman's work anchors on the development and application of state-of-the-art human brain mapping techniques. One such technique is real-time functional Magnetic Resonance Imaging (rt-fMRI), which makes it possible to observe the biology of one's own brain while thinking, feeling and acting. Recent evidence suggests that people can learn to control brain activation in localised regions, with corresponding changes in their mental operations, by observing information from their brain while in an MRI scanner. For example, subjects can learn to deliberately control activation in brain regions involved in pain processing with corresponding changes in experience of pain. Other potential applications encompass substance abuse.

This technique may provide a novel, non-invasive means of observing and controlling brain function, potentially altering cognitive processes or disease.

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## **Electroencephalography research**

*Dr Peter Malinowski ([p.malinowski@ljmu.ac.uk](mailto:p.malinowski@ljmu.ac.uk))*

*Liverpool John Moores University*

The workshop presentation by Dr Peter Malinowski focused on the basic principles of EEG research and related research methods and approaches to data analysis. Three basic ways of using the EEG signal were distinguished:

evoked potentials (transient or steady-state), induced oscillating activity and spontaneous (i.e. not directly stimulus dependent) ongoing activity. Within LJMU's School of Natural Sciences and Psychology two state of the art (BioSemi) EEG-systems with active electrodes are in use, one 64-channel system (Peter Malinowski) and a 32-channel system (Stephen Fairclough).

Dr Peter Malinowski's main research focus is on investigating principles and underlying neural mechanisms of attentional processes, especially in the visual domain. This is more and more applied in the area of meditation research where psychological as well as physiological effects of attentional functions due to meditation training are studied. In relation to pain research, there would also be scope to study the effects of mindfulness- and acceptance-based interventions in treating chronic pain.

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## **Virtual Rehabilitation**

*Dr Gabor Barton ([g.j.barton@ljmu.ac.uk](mailto:g.j.barton@ljmu.ac.uk))*

*Liverpool John Moores University*

Gabor gave an update of the ongoing research project funded by The WellChild Trust and Alder Hey Children's NHS Foundation Trust. Custom made computer games are developed with a focus on testing and training the control of pelvic and trunk movements. The real time visual and somatosensory biofeedback is expected to improve the movement control of the core of the body thanks to the capacity of the CAREN system fulfilling the three prerequisites of motor learning – repetition, feedback and motivation (Rizzo). Integration of XSens sensors in the games makes it possible to move the complex research tool out to the clinic and eventually to the home environment for children with cerebral palsy to improve their movement functions.

The new directions in Gabor's work are to do with real time visual feedback of dynamic movements combined with the visualisation of muscle actions using MOTEK's Human Body Model package. There is also scope for exploring the use of virtual reality in pain management, particularly in the reduction of phantom limb pain using a virtual mirror box. Functional MRI may offer the ultimate outcome measure of neuroplasticity in response to virtual rehabilitation.

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## **Real-Time Movement Analysis**

Mark Robinson ([m.a.robinson@ljmu.ac.uk](mailto:m.a.robinson@ljmu.ac.uk))

*Liverpool John Moores University*

This technology allows Biomechanists to accurately track the position of retro-reflective markers in real-time using infra-red cameras. By placing the markers on anatomical landmarks a representation of the movements of underlying bones can be achieved. A practical demonstration at the workshop showed the motion capture technology (Qualisys, Sweden) and the streaming of an upper limb model consisting of thorax, upper arm and lower arm segments into a visualisation and calculation software package (Visual 3D, C-Motion, USA).

Mark Robinson's current research includes the functional assessment of muscle transfers in tetraplegic patients at Southport Spinal Injuries Centre.

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## **Physiological computing**

Dr Steve Fairclough ([s.fairclough@ljmu.ac.uk](mailto:s.fairclough@ljmu.ac.uk))

*Liverpool John Moores University*

Physiological computing is a new human-computer paradigm where real-time psychophysiological measures of the user state are used to adapt a computer system in real-time. For example, psychophysiological measures of task

engagement would allow a computer-based learning system to adapt itself to ensure that the user remains on-task, i.e. by offering help if the user is stuck on a task or pacing the task to ensure that the user remains challenged. This system concept may be adapted to cyber-therapy applications where it is important to personalise the program of activity to an individual in real-time, e.g. to sustain engagement with therapy, integration of games and biofeedback. Research associated with this area includes: psychophysiological assessment of relevant states, developing real-time data analysis and diagnosis protocol, designing software with appropriate interface design and adaptive dynamic strategies.