Page 1 – General Information

Project code	TSAB05
Partner University	Teesside University
Faculty/School/Department/Research Centres	Centre for Rehabilitation, Exercise and Sport Science, School of Health and Social Care
First supervisor Please provide name and weblink	Dr Daniel Eaves https://research.tees.ac.uk/en/persons/daniel-eaves
Second supervisor Please provide name and weblink	Dr Alison Innerd https://research.tees.ac.uk/en/persons/alison-innerd
Third supervisor Please provide name and weblink	Professor Denis Martin https://research.tees.ac.uk/en/persons/denis-martin
Fourth (external) supervisor	Professor Paul Holmes Manchester Metropolitan University https://www2.mmu.ac.uk/cheshire/about-us/senior-management-team/professor-paul-holmes/ Dr David Wright Manchester Metropolitan University https://www2.mmu.ac.uk/shs/staff/profile/index.php?id=1599
External/industrial supervisor	Mr Robin Bedford Health and Physical Activity Development Manager, Public Health South Tees Teesside Stroke Club (local charity organisation) https://en-gb.facebook.com/teessidestrokeclub/

Which of the supervisors listed above is an early-career-researcher	Dr Daniel Eaves Dr Alison Innerd
Contact details for project for informal applicant queries Email address	d.eaves@tees.ac.uk
DTA Programme	DTA Applied Biosciences for Health
Project title	Investigating novel methods for home-based stroke rehabilitation: combining action observation and motor imagery therapy with integrated technology

Doctoral Training Alliance

Page 2 – Project Description

Scientific Excellence (500 words)	Stroke is a leading cause of motor deficiency in millions of people worldwide. Unfortunately, the number of people affected by stroke will inevitably rise as global life expectancy increases. The prevalence of motor deficits following a stroke can be up to 80% in a defined elderly population. Only a small proportion of this group (approximately 20%) will partially recover, leaving approximately 50-60% who are left with some form of chronic motor deficiency.
	Post-stroke neuro-rehabilitation uses different training methods to try and reduce motor deficits. This typically involves repetitive physical training and physical therapy. When physical training is not possible or appropriate (e.g., due to fatigue), two types of mental practice are recommended. Action observation therapy involves systematically observing actions before execution, and motor imagery requires participants to simulate mentally the visual and kinaesthetic aspects of their actions without physically moving.
	While these two methods are both effective and well-suited for home-based therapy, behavioural and neuroscience research conducted by DE, DW and PH (using healthy adults) shows significantly greater benefits for a novel combination of action observation and motor imagery (AO+MI) instructions. This instruction involves imagining the kinaesthetic experience and sensations of action, while also observing a visual display of the same action at the same time. Participants are normally instructed to synchronise their imagined action with the observed movement in real-time. While this approach is predicated on a growing body of multimodal brain imaging research showing beneficial effects, preliminary intervention-based work in healthy adults has also shown advantages in movement performance.
	Our recent reviews (2016, Frontiers in Neuroscience; 2018, Aims Neuroscience) further concluded that there is now a strong body of neuroscientific evidence advocating the use of

	combined AO+MI instructions as a rehabilitation tool, but longitudinal studies are currently lacking in target populations. We have recently completed an eight-week pilot intervention in collaboration with Public Health South Tees and Teesside Stroke Club. The results show combined AO+MI instructions can significantly enhance motor re-learning in stroke survivors. This paves the way for research to now investigate the efficacy of this method as a home-based intervention. This would be to maximise patient outcomes in physical ability, daily living and mental health. From the practitioner and service delivery perspective, home-based therapy also has the potential to reduce rehabilitation times and enhance the cost-benefits in the delivery of face-to-face therapy. The purpose of the current project is to assess the potential for home-based AO+MI therapy to be integrated with existing technology to support post-stroke rehabilitation.
Aim (400 words)	**Aims** 1) Investigate the effectiveness of home-based combined action observation and motor imagery (AO+MI) therapy for improving post-stroke rehabilitation. 2) Assess the feasibility of different app-based technologies for supporting the delivery of this therapy. **Outcomes** Patient outcomes will be assessed in terms of improvements in life quality, mental health, and physical function. Movement screening tools include the Action Reach Arm Test and Nine Hole Peg Test, with bespoke tasks designed to quantify speed and accuracy in the home-based AO+MI therapy movements.

An economic evaluation will establish cost-effectiveness of the programme, identifying optimal implementation strategies for embedding and normalising the programme beyond the study.

Methodology and innovations

At Manchester Metropolitan University, PH developed an iPad-based application for home-based movement therapy for stroke called: See, Imagine, Move; Upper Limb Action Therapy (SIMULATe). The public involvement and feasibility work has also developed and tested the usefulness of this application for rehabilitation in Parkinson's disease patients. Users select from a library of functional everyday movements and engage in imitation and motor imagery to enhance their movement skills.

At Teesside University, DM develops digital approaches to health management. He has created immersive virtual reality platforms for supporting different patient groups, such as pain management in chronic pain suffers.

There is now a clear opportunity to develop these technologies further, in line with the specific needs of stroke survivors.

Phase 1:
Evaluate the user experience of technology supporting AO+MI therapy

Conduct a review of literature into home-based therapy techniques for rehabilitation in brain injured and neurodegenerative patients.

Triangulate the existing evidence from public involvement(PI) research.

Conduct a PI consultation with stroke survivors investigating rehabilitation, mental practice techniques, and the use of assistive technology.

- Evaluate user experience for SIMULATe in stroke survivors and practitioners. Users self-select a 'playlist' of functional everyday movements. They observe these

	actions whilst simultaneously imagining the sensations associated with executing the movement themselves, before practicing the action physically.
	- Scope the potential for alternative technological innovations in the delivery of AO+MI therapy, such as immersive virtual reality platforms.
	Phase 2: **Assess the feasibility and effects of AO+MI therapy via integrated digital technology** Pilot a randomised controlled trial (RCT). Assess patient and practitioner views regarding perceived costs and benefits of the intervention. The project plan will give clear direction to the student while allowing appropriate space for the student to develop their own ideas to facilitate ownership of the project.
Strategic Relevance (300 words)	This research aligns closely with Teesside University's strategic Grand Challenge Theme of Health and Well-being. Accordingly, this research is also directly related to and informed by the public health agenda in the UK. By working closely with Public Health South Tees at the Live Well Centre in Middlesbrough, we are able to deliver this strategic vision at a local level, aiming to engage in a socially and ethically minded way with our local community, in an economically deprived area. This project also falls within the remit of FUSE: the Centre for Translational Research in Public Health. This collaboration brings together the five North East Universities of Durham, Newcastle, Northumbria, Sunderland and Teesside to deliver robust research to improve health and well-being and tackle inequalities. FUSE works hand-in-hand with the NHS, local and national government, voluntary and community sectors to help transform public health.

	The proposed project complements the work currently being undertaken by staff and PhD students within the Centre for Rehabilitation and Exercise at Teesside University, who are exploring motor learning, imitation and balance. This work also enables collaboration with colleagues in Manchester who could extend their initial feasibility work and extend this into a randomised control trial.
Interdisciplinarity and fit with DTA3	Stroke survivors tend to be aged over 60 years, and often have cognitive impairments, such as in memory and decision making. They are also prone to feelings of isolation and depression and may disengage from society as a result. This project draws together expertise in cognitive neuroscience, psychology, assistive technologies, and in the strategic delivery of physical activity interventions for enhanced patient outcomes. The overall aim is to use the insights gained from the team's broad experience in applied biosciences for health to improve the overall health and well-being of society, with a particular focus on those facing movement inequalities resulting from a stroke.
Industrial Relevance (300 words)	A real strength of this application is that our established cross-institution collaborations are highly relevant to industry. Specifically, this refers to those occupations involved in promoting public health, physical activity, rehabilitation and exercise, as well as the use of assistive technology in health and user engagement. There is an opportunity to visit the Psychological Sciences Research Institute at the Université Catholique de Louvain, in Brussels, Belgium. Professor Martin Edwards and his team are currently investigating the use of robots and assistive technology in stroke rehabilitation. The candidate will have the opportunity to learn about the techniques used in Belgium,

	which will enrich the work undertaken locally at Teesside University and Manchester Metropolitan University. Our integrated work with Public Health South Tees, will allow the candidate to explore a range of work placement opportunities across their service, with the chance to meet a range of specialists in exercise referral, and the service users themselves. The purpose will be to gain a clear understanding of the principles of best practice in the delivery of interventions when working with target populations. This will also provide an opportunity for direct dissemination of the findings to those working in the industry. The candidate will also be able to visit Manchester Metropolitan University to gain insights into the development process behind the SIMULATe app. They would acquire knowledge in the design of digital technology for improving health and user engagement. They would also gain critical knowledge and understanding from academics in Manchester (DW and PH) who are experts in the neurophysiological assessment and practical delivery of combined action and observation methods. Since DE also has expertise in this area at Teesside, this project will provide an excellent opportunity for knowledge exchange on this topic between the two institutions. Based on the success of this project a logical avenue for future projects will be to use this home-based AO+MI therapy approach, and adapt the technology and protocols for different public health initiatives, such as support for multiple sclerosis patients, and fall prevention in aging populations.
Economic and Societal Impact (300 words)	From the practitioner and service delivery perspective, this home-based therapy has the potential to reduce rehabilitation times and enhance the cost-benefits of delivering face-to-face therapy. An economic evaluation will therefore aim to establish the cost-effectiveness of the programme, identifying optimal implementation strategies for embedding and normalising the programme beyond the study.

If successful, recommendations from the study to adopt this type of home-based training may help to reduce the volume of basic care required from practitioners, helping them to move more efficiently toward the mode of care needed in the latter stages of the rehabilitation process. Depending on the severity of the brain injury, there may also be a potential to help stroke survivors return to work earlier, for example, if combined AO+MI therapy can help to reduce rehabilitation periods. In turn, this would reduce the associated workload and costs involved in the delivery of motor rehabilitation through exercise referral schemes in the community.

Our engagement with Teesside Stroke Club (local charity organisation) is an important part of this project. They are a community-facing organisation, who interact directly with the lives of patients. They aim to increase community engagement and provide social support for stroke survivors and their carers.

The success we have already had in the recent pilot intervention work has helped to raise the profile of Teesside Stroke Club. Their engagement with our project has been a crucial driver behind its success. The proposed home-based therapy would therefore work well to complement and expand their work, which aims to improve lives in the community. Addressing movement inequalities through this project, gives people the opportunity to move better, and therefore live more independent and fulfilling lives, which in turn can impact positively on those around them.

Page 3 – Admission Requirements

Specific Admission Requirements	Applicants should have a good first degree and masters qualification in a related discipline, including (but not limited to) sport and exercise science, physiotherapy, cognitive neuroscience, psychology, computer programming.
Minimum IELTS score	International applicants must have a minimum IELTS score of 6.5 in writing alongside a minimum of 6.5 in reading, listening and speaking with a minimal overall score of 6.5, all within the last two years.