IMAGERY, MIRROR BOX THERAPY AND ACTION OBSERVATION IN STROKE

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Abstract

Imagery, mirror box therapy and action observation are simple, inexpensive and patient led treatments that can be used to aid in the improvement of motor function in both the upper- and lower-extremities post-stroke. This thesis examined the effects of imagery on physical movement post-stroke and therapists' use of imagery, mirror box therapy and action observation as part of stroke rehabilitation. Study one was a meta-analysis investigating the effect of imagery on upper- and lower-limb movement ability post-stroke. The results revealed that imagery produced a moderate mean treatment effect (p= 0.03; d= 0.48; 95% confidence interval: 0.05 to 0.91). Imagery that was performed in the third person and performance analysis (the identification of incorrect task performance to help facilitate a positive change in performance) showed the largest improvements in movement. However, the effectiveness of imagery during stroke rehabilitation is still uncertain, as indicated by the large confidence interval. The second study investigated the extent to which physiotherapists and occupational therapists in the UK used cognitive therapies during stroke rehabilitation. In addition, how the therapies were conducted and the therapists' views on their delivery were investigated. The skill audit had a response rate of 25% and showed that during stroke rehabilitation 68% (91/133) of therapists used imagery, 53% (68/129) used action observation and 41% (52/128) used mirror box therapy. Only 12% of therapists had received specific training in these therapies and therapists would like guidance on how to administer cognitive therapies. Unfortunately, due to the poor response rate the skill audit data may not be generalizable to the whole stroke therapy population. To conclude, the meta-analysis and skill audit have highlighted the potential of cognitive therapies and will help inform the production of clinical guidelines on the use of cognitive therapies during stroke rehabilitation. Clinical guidelines would help standardise the delivery of cognitive therapies and inform therapists how to motivate patients', post-stroke.

Abbreviations used Throughout the Thesis

ADL Activities of Daily Living

AMCL Amsterdam-Maastricht Consensus list for Quality Assessment

ARAT Action Research Arm Test

DGI Dynamic Gait Index

EMG Electromyography

ESD Early Supported Discharge

FAT Frenchay Arm Test

FIM Functional Independence Measure

FMA Fugl-Meyer Assessment of Sensory Recovery

fMRI Functional Magnetic Resonance Imaging

GAS Goal Attainment Scaling

GMI Graded Motor Imagery

hMNS Human Mirror Neuron System

KVIQ Kinaesthetic and Visual Imagery Questionnaire

NEADLS Nottingham Extended ADL Scale

NICE National Institute for Health and Care Excellence

OT Occupational Therapy

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

QOL Quality of Living

RCTs Randomised Control Trials

RMI Rivermead Mobility Index

SIS Stroke Impact Scale

TUG Timed Up and Go

RCTs Randomised Control Trials

SINAP Stroke Improvement National Audit Programme

SSNAP Sentinel Stroke National Audit Programme

WMRT Wolf Motor Function Test

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Chapter One: Introduction

1.1. Causes of a stroke

The Stroke Association (2015) has estimated that each year in the UK 152,000 people have a stroke, claiming 40,282 lives. Stroke is the leading cause of long-term disability in adults, with half of all stroke survivors left with a disability (Stroke Association, 2015). A stroke is caused by a disruption of blood to the brain via a blood clot (ischaemic stroke) or the bursting of blood vessels (haemorrhagic stroke), which prevents blood from reaching brain cells. The brain uses approximately 20% of all the oxygen consumed by the body (Kalat, 2013). An interruption of one to two minutes to a brain cell's oxygen supply can cause the brain cells to become dormant, but the brain cells can be reactivated through rehabilitation. However, if the oxygen supply is disrupted for a minimum of four minutes irreversible brain damage occurs resulting from the brain cells dying (Saladin, 2004).

Around 1.9 million neurons are lost every minute a stroke is untreated (Saver, 2006). Raising the awareness of stroke symptoms can help reduce the amount of time it takes for individuals to recognise a stroke has occurred, leading to individuals seeking medical attention quicker. The Stroke Association have been working in partnership with Public Health England to make sure as many people as possible know to Act FAST to save a life. The Act Fast campaign raises the awareness of the FAST test which identifies key symptoms of a stroke (Facial weakness, Arm weakness, Speech problems and Time to call 999) and that a stroke and mini-stroke (TIA) are a medical emergency. There will be adverts again throughout February 2015 depicting how to conduct the FAST test. Since the Act FAST campaign began in February 2009 more than 38,000 people have arrived at hospital sooner because of the public and paramedics recognising when someone is experiencing a stroke (Stroke Association, 2015). Time is very important when a stroke has occurred because the sooner a patient receives treatment the quicker stroke progression is halted and less brain cells are damaged. Stroke mortality rates are continually falling, but stroke causes a greater range of disabilities than any other condition (Adamson, Beswick, & Ebrahim, 2004) with the most common difficulty being upper-limb weakness (Lawrence et al., 2001) and the least common emotionalism (Hackett, Yang, Anderson, Horrocks, & House, 2010). This highlights that a stroke can cause physical and psychological difficulties, which will be discussed in more detail in the next two sections.

1.2. Physiological effects of stroke

The area of brain tissue that has been damaged directly relates to the effects of stroke. If damage occurs to the motor area of the right cerebral hemisphere weakness in the left arm, leg and face can occur (Hildyard, Goddard, & Horobin, 2008). The second most common difficulty is lower limb movement problems and weakness, with 72% of individuals post-stroke being affected (Adamson, Beswick, & Ebrahim, 2004). Individuals with lower-limb weakness sometimes need to use a wheelchair for transportation or a walking frame to support them then walking. Muscle weakness occurs because of a reduction in muscle mass and fibre length reducing the number of contractile protein (actin and myosin) filaments being parallel to each other (Gray, Rice, & Garland, 2012). Individuals may experience problems in muscle coordination resulting in movements becoming jerky and with reduced range of motion. Sometimes limbs can become spastic following a stroke, with muscle cross-bridges becoming fixed in one position instead of the actin filament and myosin head constantly moving apart then overlapping again (Gray et al., 2012). This results in muscles feeling stiff and tight, reduces range of movement and is sometimes painful. Finally, following a stroke an individual may become less sensitive, for example, to taste (Heckmann et al., 2005). Movements are often performed at slower speeds as the rate of neural impulses reduce, with individuals having to consciously think about movements instead of them occurring automatically. Increased levels of concentration can lead to increased levels of fatigue.

1.3. Cognitive effects of stroke

As well as physiological effects following stroke, psychological problems can also occur. The Stroke Association (2013) suggested that the areas of cognition that are most commonly affected are memory, attention, perception and communication. Stroke-affected individuals may experience problems with their short and long-term memory (Baumann, Couffignal, le Bihan, & Chau, 2012) and find it difficult to learn new information (Pound, Gompertz, & Ebrahim, 1998). Individuals can also experience difficulty in selecting what information requires attention and can easily become distracted, have difficulty filtering out distracting information (e.g., background noise) and experience difficulty when multi-tasking (Olai, Borgquist, & Svärdsudd, 2012). As well as having problems with selecting the correct information after a stroke, difficulties can occur when trying to interpret that information and verbally respond (Pound et al., 1998). Consequently, cognitive difficulties following a stroke can result in communication problems (aphasia; Royal College of Speech and Language Therapists, 2010).

1.4. The impact of stroke on individuals' lives

The effects of stroke impact individuals' lives in many different ways. Stroke-affected individuals often become increasingly more dependent on others for help when trying to perform activities of daily living (ADL), because of their reduced physical function (Biegel, Sales, Schulz, & Rau, 1991). Becoming more dependent on others can result in individuals feeling frustrated and a nuisance. Research by Kim, Warren, Madill, and Hadley (1999) highlighted that individuals one to three years post-stroke place high importance on having the ability to get around, having the ability to do things, being useful to others and the ability to have a job. The more independent individuals affected by stroke can be, the better their quality of living (QOL; Kim et al., 1999). By improving movement function post-stroke through rehabilitation, stroke-affected individuals may become more independent and regain control of their lives.

1.5. Current support from the NHS following a stroke

The Intercollegiate Stroke Working Party (2012) produce guidelines based on the stroke care literature to help improve the quality of care delivered to everyone who has a stroke. The guidelines are called National Clinical Guideline for Stroke and inform commissioners, clinical staff and managers about stroke management during the acute phase, secondary prevention, recovery phase and long-term recovery. The National Clinical Guideline for Stroke is produced every four years, with the latest version being published in 2012. In 2005, the National Institute for Clinical Excellence merged with the Health Department Agency to form the National Institute for Health and Care Excellence (NICE), to provide national guidance and advice to improve health and social care. NICE also produce detailed guidelines on stroke care management and have worked with the Intercollegiate Stroke Working Party to provide recommendations on the content of the National Clinical Guideline for Stroke since the third edition in 2008.

According to the NICE guidelines for acute stroke (NICE, 2014), as soon as an individual has been confirmed to have experienced a stroke, brain imaging should occur immediately (within an hour) if patients are; (1) likely to be administered thrombolysis, (2) known to have a tendency to bleed, (3) on anticoagulant treatment, (4) experiencing decreased levels of consciousness, neck stiffness, fever, severe headache at onset of stroke. Otherwise, brain imaging is performed within 24 hours. Thrombolysis is the process of administering a drug (alteplase is recommended by NICE [2014]) which breaks up blood clots. Thrombolysis can only be administered within 4.5 hours from the onset of stroke symptoms and if brain imaging has ascertained that, an intracranial haemorrhage has not occurred. When patients have thrombolysis within 3 hours research has found a 9% increase in patients' dependency six months post-stroke (Wardlaw et al., 2012) and improvements in self-reported function 18 months post-stroke (IST-3 Collaboration Group, 2013). However, thrombolysis is not performed when onset of stroke like symptoms occurs greater than 4.5 hours, as the risks of mortality and further intracranial haemorrhaging out weight recovery benefits (Brown, Macdonald, & Hankey, 2013). It is therefore important for brain imaging to occur as soon as possible after a person has been confirmed of experiencing a stroke. Unfortunately, approximately 6 in 10 individuals in England, Wales and Northern Ireland who attend A&E having suffered a stroke arrive out of time to receive thrombolysis or the stroke happened when they were asleep so they do not know when the symptoms started (Royal College of Physicians, 2014).

Following thrombolysis or straight after brain imaging if patients do not meet the criteria for thrombolysis, patients should be admitted to a specialist acute stroke unit (NICE, 2014). Within 24 hours stroke affected individuals should have their understanding and swallowing checked before being assessed by a physiotherapist or occupational therapist. Therapists should assess patients within 72 hours of being admitted to an acute stroke ward (Royal College of Physicians, 2014). The role of a physiotherapist is to identify and maximize movement, of individuals with health problems, through health promotion, preventative health care and rehabilitation. Physiotherapy includes manual therapy, therapeutic exercises and electro-physical modalities (NHS Careers, 2015). Occupational therapists work with patients to develop specific strategies to overcome barriers affecting their independence. Occupational therapy includes performing daily activities such as making a hot drink, cooking and using public transport (Collage of Occupational Therapists, 2015).

The National Clinical Guideline for Stroke recommend that therapy sessions be offered for a minimum of 45 minutes 5 days a week at a level that enables patients to meet their rehabilitation goals and for as long as they are benefiting from therapy (Intercollegiate Stroke Working Party, 2012). To help improve stroke-affected individuals' movement ability a number of interventions have been developed. These include exercise training (Saunders, Greig, Mead, & Young, 2009), arm re-education (Langhorne, Coupar, & Pollock, 2009), electromyographic (EMG) biofeedback (Armagan, Tascioglu, & Oner, 2003), restoration of postural stability (Weerdestexn, de Niet, van Duijnhoven, & Geurts, 2008), gait retraining (Mehrholz, Werner, Kugler, & Pohl, 2007) and constraint-induced movement therapy (Wolf, Winstein, & Miller, 2006). These rehabilitation methods are outlined in the National Clinical Guideline for Stroke (Intercollegiate Stroke Working Party, 2012). However, most of the rehabilitation methods mentioned are not always practical as they are labour intensive and require one to one interaction with therapists for several weeks. These rehabilitation methods predominantly focus on improving physical function without taking into consideration psychological techniques which are non-invasive, physically less exhausting and can be used in conjunction with physical therapy.

Stroke affected individuals with a mild to moderate disability, can be put onto the early supported discharge (ESD) pathway, so they are discharged from hospital sooner and receive therapy at home. Typically, ESD lasts for about six weeks and 66% of hospitals have access to ESD (Royal College of Physicians, 2014). Unfortunately, only 26% of stroke patients in England, Wales and Northern Ireland are discharged with ESD services. In areas of the country without ESD, patients have to wait for up to 8 weeks for community therapy services. When leaving hospital therapists do give patients activities to practice when at home, but without therapists supervision it is unknown whether practice occurs at home and if activities are performed correctly. Cognitive therapies could be used at home to keep patients engaged in rehabilitation whilst waiting for community rehabilitation and between therapy sessions.

The Stroke Association (2015) have campaigned to secure Government backing to ensure everybody affected by stroke receives the best possible care available. In 2007 the Department of Health launched the National Stroke Strategy for England for the next 10 years. The strategy provides advice for stroke service planners and providers to judge and improve the quality of their services. In April 2011 the Stroke Improvement National Audit Programme (SINAP) started collected information from hospitals about acute stroke care within the first 72 hours post stroke. SINAP aimed to improve the quality of patients stroke care by measuring hospitals performance against evidence based standards. The Sentinel Stroke National Audit Programme (SSNAP) superseded SINAP in December 2012. For the months of July-September 2014 SSNAP (Royal College of Physicians, 2014) found that the median number of minutes per day that occupational therapy was received in hospital was 40.8, which is 23.9% less than recommended in the National Clinical Guideline for Stroke (Intercollegiate Stroke Working Party, 2012). In addition, occupational therapy only occurred on 59% of the days patients were in hospital. Physiotherapy sessions were shorter than occupational therapy sessions at 32.9 minutes, which is 30.1% less than recommended. However, physiotherapy sessions occurred more frequently, as they occurred on 68.5% of days spent in hospital. If occupational and physical therapy only occurs 5 days a week then patients can only receive therapy a maximum 71.4% of days in hospital. On days when therapy is not being conducted patients are likely to be left on the ward with no stimulating activities to participate in.

According to the Department of Health (2007) within the first six months following a stroke only half of individuals affected by stroke, receive the rehabilitation they need to live at home. With more people surviving a stroke and living with a disability the number of patients who require therapy increases, putting extra strain on therapists' time and resources. Individuals affected by stroke might experience that they still have rehabilitation needs that are not being addressed by physiotherapists and occupational therapists. Cognitive-related treatments such as imagery, mirror box therapy and action observation could enable patients to take control of their rehabilitation through conducting therapy independently from a therapist, between therapy sessions. Cognitive therapies could also help reinforce activities learnt during therapy sessions.

1.6. The use of cognitive therapies following a stroke

A potential solution that could enable stroke rehabilitation methods to be more practical, inexpensive and performed by patients independently is the use of cognitive therapies. Cognitive therapies such as imagery (Page et al., 2005), mirror box therapy (Yavuzer et al., 2008) and action observation (Ertelt et al., 2007) are structured therapy methods that attempt to change positively the patients thoughts, emotions and behaviours, resulting in possible associated changes in physical function and behaviour (Beck, Rush, Shaw, & Emery, 1979). Imagery is a mental technique in which physical skills are cognitively rehearsed in the absence of overt physical movement (Page, 2000; Page, Levine, Sisto, & Johnston, 2001a). Physical movement is also absent during action observation, but movements are observed with the intent to imitate (Pomeroy et al., 2005). However, mirror box therapy involves the performance of bilateral arm movements while the impaired limb is obscured from sight by the box. The patient watches the movement of the unimpaired limb in the mirror reflection, thus giving the illusion that the impaired limb is moving unaffected with enhanced movement capability.

Imagery, mirror box therapy and action observation help enable neuroplastic adaptations to occur (Ewan, Kinmond, & Holmes, 2010a). Neural adaptations are a potential way of improving rehabilitation outcomes (Ewan et al., 2010a). Following a stroke, the adult brain is capable of intensive remodelling (Carmichael, Wei, Rovainen, & Woolsey, 2001), which can be aided by cognitive therapies. Imagery and action observation stimulate similar areas of the brain that are active during physical performance of the imaged or observed task (Cochin, Barthelemy, Roux, & Martineau, 1999; Lotze et al., 1999). Mirror box therapy provides neural activation in the affected brain areas as a direct consequence of the visual stimulation, associated with the unaffected limb movement, from the mirror (Yavuzer et al., 2008). However, Schuster et al. (2011) have identified that there are conflicting results in the literature making it unclear whether the use of imagery during physical practice improves limb movement.

A lack of clarity in the literature regarding best practice methods of imagery, mirror box therapy and action observation has inhibited their inclusion in guidelines for stroke rehabilitation by medical organisations. Only imagery is included in the National Clinical Guideline for Stroke (Intercollegiate Stroke Working Party, 2012) and guidance on how to use it is often superficial. Therefore, the studies described in this thesis investigated whether imagery produced a positive effect on movement ability post-stroke and whether cognitive therapies are currently being used by therapists during stroke rehabilitation.

Chapter Two: Literature Review

The aim of this literature review was to critically discuss research findings to date in the areas of imagery, mirror box therapy and action observation. The literature review details the use of the cognitive therapies in sport, and in the treatment of neurological disorders such as phantom limb pain and cerebral palsy. However, the focus of the literature review was on the use of imagery, mirror box therapy and action observation during stroke rehabilitation. Several methodological issues and gaps in the literature have been identified. Suggestions on how to overcome these issues and how to add to the body of knowledge have been proposed during this chapter.

2.1. Neuroplasticity and functional recovery post-stroke

According to Kantak, Stinear, Buch, and Cohen (2011) the brain is a plastic organ that has the capabilities to reorganise in response to behaviours and/or injury. It is possible for healthy aging individuals to prevent loss of cognition and even improve motor learning through plastic change (Vance & Crowe, 2006). Individuals should perform health behaviours, engage is stimulating activities and cognitive training techniques. This could lead to positively influencing physiological functioning of the brain and increase the ability to compensate for any declines in cognition and movement (Vance & Crowe, 2006).

The advancement of brain imaging and other neurophysiologic techniques have enabled the mechanisms of post-stroke recovery to be better understood (Taub, Uswatte, & Elbert, 2002). Such understanding is vital when developing new therapies that promote post-stroke recovery. Recovery of function depends on the capacity of the surviving brain cells to recover and repair in response to rehabilitation (Kantak et al., 2011). Short-term recovery (hours to days) following a stroke has been suggested to occur due to the resolve of oedema (abnormal accumulation of fluid in the tissues of the body, which causes swelling) and the recovery of tissue function to tissues that were not destroyed during the stroke (Hallet, 2001). Longer-term recovery (weeks to months) seems to occur because of neuroplastic changes at a cortical and subcortical level (Nudo, Barbray, & Kliem, 2000). The term brain plasticity has been suggested to encompass all possible mechanisms that are associated with neural reorganisation (Rossini, Calautti, Pauri, & Baron, 2003).

Most therapies during stroke rehabilitation are based on motor learning and promoting neuroplasticity. During motor learning post-stroke, dendrite sprouting, the formation of new synapses and alterations in existing synapses have been found to occur (Arya, Pandian, Verma, & Gary, 2011). These changes are thought to provide as an automatic substrate to facilitate motor recovery post-stroke. Motor learning has been found to be greater if the therapy is meaningful, repetitive and intensive (Arya et al., 2011). Interestingly, one therapy has been proposed to improve neuroplasticity, which is imagery (Sun et al., 2013). This therapy will be discussed in the next section.

2.2. Imagery: An overview

The use of imagery during sport to enhance performance has been advocated by psychologists, athletes and coaches since the late nineteenth century (Moran & MacIntyre, 1998). Imagery is one of the most common components of most sport psychology interventions (Morris, Spittle, & Watt, 2005). It has been used to enhance performance because it enables athletes to use multimodality experiences of successful performances, focus on the key elements that contribute to success and to develop strategies to enhance performance in the future (Hale, 2005). Imagery allows athletes to identify their own, and opponent's strengths and weaknesses, informing strategy development. Another benefit of imagery is that similar brain structures have been found to be active during imagery and actual performance (Munzert & Zentgraf, 2009).

The high degree of neural overlapping between imagery and physical performance is termed functional equivalence (Holmes & Collins, 2001). During imagery the activated neuronal groups fire and interact in defined patterns, allowing them to structurally modify and become more effective (Jeannerod, 1994).

Athletes most commonly perform imagery to focus on improving the performance of specific motor skills; this is known as cognitive specific imagery (Weinberg, 2008). This type of imagery enables athletes to become familiar with the feel of the movement and facilitate improvements in skill level. Researchers have argued that imagery might be more effective in closed motor skills, as the environment is more predictable, compared to motor skills that are performed in ever changing environments (Coelho, de Campos, da Silva, Okazaki, & Keller, 2007). Imagery of closed skills allows athletes to image in their own time and without distractions from an opponent (Highlen & Bennett, 1979). For example, the effectiveness of imagery in enhancing specific closed motor skills has been reported in sports such as gymnastics, golf, the tennis serve and basketball free-throw (Smith, Wright, Allsopp, & Westhead, 2007; Smith, Wright, & Cantwell, 2008; Coelho et al., 2007; Wrisberg & Anshel, 1989). The effectiveness of imagery also improved when performed with the physical characteristics (Holmes & Collins, 2001), in the environmental context of (Callow, Roberts, & Fawkes, 2006) and at the same arousal level as observed during physical practice (Holmes & Collins, 2001; Louis, Collet, & Guillot, 2011). Imagery should also ideally match the spatial and temporal characteristics of the physical movement, in order to reinforce the correct movement timing (Guillot, Hoyek, Louis, & Collet, 2012).

As imagery can facilitate the learning of motor skills in a sporting context it would be interesting to investigate whether individuals affected by stroke can benefit in a similar manner as athletes. If imagery is effective at enhancing motor skills of stroke-affected individuals it could benefit the lives of a large population of people.

2.3. Imagery in stroke rehabilitation

Although imagery was initially used to improve the performance of athletes (Mehrholz et al., 2007), it has recently been applied in stroke rehabilitation to improve motor recovery (Jackson, la Fleur, Malouin, Richards, & Doyon, 2001). Imagery has only recently begun to find its way into guidelines for stroke rehabilitation by medical organisations and guidance on how to use it is often superficial. For example, the National Clinical Guideline for Stroke (Intercollegiate Stroke Working Party, 2012) recommended that patients should be encouraged to use imagery alongside conventional therapy to help improve arm function. However, they gave no information as to how the imagery should be performed. The Intercollegiate Stroke Working Party (2012) suggested that imagery should only be used to improve arm function. In contrast, research by Hwang et al. (2010) has shown that imagery can also lead to improvements in lower-extremity motor function, leading to the improvement of gait performance. Guidance on how to use imagery may be superficial because there are conflicting results in the literature regarding the benefit of imagery during stroke rehabilitation. For example, Dunsky, Dickstein, Marcovitz, Levy, and Deutsch (2008) and Ietswaart et al. (2011) did not find imagery to improve movement post-stroke, this will be discussed in section 2.4.5. of the literature review. The conflicting results and variations in study methodologies are making it unclear how best to implement imagery with stroke-affected individuals, consequently preventing clinicians from receiving detailed imagery guidelines.

The Intercollegiate Stroke Working Party (2012) has not included any information regarding at what stage of rehabilitation imagery should be introduced.

Imagery has been found to be beneficial during the early stage of rehabilitation when little or no movement is possible (Lotze & Cohen, 2006; Page et al., 2001a; Tamir, Dickstein, & Huberman, 2007). The essence of imagery use in stroke rehabilitation is teaching patients mental imagery strategies that facilitate the reorganisation of the affected areas of the brain by recruiting intact neurons and increasing the activity in other neuronal loops (Lotze & Cohen, 2006; Tamir et al., 2007).

Reorganisation of the affected areas of the brain following a stroke helps improve movement (Tamir et al., 2007). Hewett, Ford, Levine, and Page (2007) found that mental imagery can aid post-stroke rehabilitation by helping to retrain movement in the paralysed limbs. Imagery has been reported by Liu, Chan, Lee, and Hui-Chan, 2004a to significantly improve stroke-affected individuals' performance in activities of daily living (ADL). These activities included cooking and shopping tasks. The imagery group in this study also performed better than the control group on untrained tasks. This indicates that imagery does not only improve the performance of familiar tasks but helps individuals to develop strategies to enable the performance of untrained tasks. Imagery could therefore aid in the promotion of relearning tasks (Liu et al., 2004a). Imagery may aid relearning because it improves attention and sequencing-processing abilities; this is indicated by improved Colour Trial Test (CTT) subscale scores in the imagery group of Liu et al. (2004a). Improved attention is associated with improvements in planning and sequential processing, leading to enhanced task performance. Improved sequential processing occurs from the generation of images depicting each stage of the daily tasks (Liu, 2002).

2.3.1. Stroke and imagery ability. Research by Hochstenbach and Mulder (1999) suggests that approximately 18% of stroke affected individuals experience impaired imagery ability. Ewan et al. (2010b) found that following a stroke, individuals produced less vivid first person and kinaesthetic imagery, but more vivid third person imagery than healthy controls. The results of Ewan et al. (2010b) support Jeannerod's (2006) proposal that individuals who have damaged the frontal and parietal lobes of the brain experience problems when generating images.

Individuals with a right hemispheric stroke have also been found to perform imagery of stepping movements at a slower speed than physical performance (Malouin, Richards, & Durand, 2012). Imagery speed was not affected in healthy controls or in individuals with a left hemispheric stroke. Imagery lasted longer in participants with lesions located in the middle cerebral artery. Therefore, stroke patients with a right hemispheric lesion might need a metronome to ensure imaged movements are performed at the same speed as physical performance.

While a stroke has been found to affect imagery ability, research by de Vries, Tepper, Otten, and Mulder (2011) found that imagery ability can recover during the first six weeks following a stroke. This highlights that patients who initially cannot perform imagery, might still benefit from imagery later in the rehabilitation process. Therefore, prior to partaking in an imagery intervention, stroke-affected individuals should have their imagery ability measured. Patients who have poor imagery ability should also be reassessed later in the rehabilitation process to monitor whether imagery ability has improved. However, Ietswaart et al. (2011) showed that hospitalised patients did not benefit from imagery.

There are numerous methods that could be used to measure imagery ability, such as validated questionnaires, mental chronometry and computer presented tasks. Malouin, Richards, Jackson, la Fleur, Durand, and Doyon (2007) have developed and validated the Kinaesthetic and Visual Imagery Questionnaire (KVIQ) with individuals affected by stroke. This questionnaire has a self-report imagery scale that can be applied to individuals with physical disabilities. The KVIQ assesses image clarity and sensation intensity when imaging. The structure of the questionnaire allows both visual and kinaesthetic imagery to be assessed. The KVIQ requires individuals to physically perform the task prior to imaging. Therefore, the tasks to be performed are simple enough to enable disabled individuals to perform them.

2.4. Imagery delivery during stroke rehabilitation

2.4.1. Participant inclusion criteria. As well as alterations to imagery ability there may also be physiological and psychological effects of stroke, such as aphasia and severe limb spasticity (Barreca, Wolf, Fasoli, & Bohannon, 2003). These effects of stroke could limit the effectiveness of imagery in improving movement ability. When conducting research into the use of imagery in stroke rehabilitation, investigators need to be careful when selecting inclusion and exclusion criteria. Barreca et al. (2003) found that the most common participant exclusion criteria were severe cognitive deficits and in some cases receptive aphasia, for example, the inability to understand written or spoken speech. If participants had receptive aphasia they would not be able to understand any instructions given to them from the experimenter thus preventing them from performing effective imagery. When selecting inclusion and exclusion criteria, researchers need to be watchful that they are not too stringent, as being so could lead to the participants only representing a small portion of the stroke population.

Both acute and chronic stroke-affected individuals have been used to investigate the use of imagery during stroke rehabilitation. Chronic stroke-affected individuals should never be excluded from rehabilitation even if it is expected that little improvement will occur (Hewett et al., 2007). Imagery has been reported to improve physical performance in acute (Liu et al., 2004a) and chronic (Page, Levine, & Leonard, 2007) stroke cases. Time post-stroke in these studies varied from seven days (Liu et al., 2004a) to 3.5 years (Page et al., 2007). A review by Malouin, Jackson, and Richards (2013), which assessed 27 imagery stroke rehabilitation studies, found that 74% of studies (20/27) included participants that experienced a stroke more than six months prior to participation in the study. A reason for researchers using participants more than six months post-stroke is that any motor improvements will unlikely be related to spontaneous neurological recovery. Thus, any functional improvements can be attributed to the imagery intervention (Malouin et al., 2013). Braun, Beurskens, Borm, Schack, and Wade (2006) found that studies did not clearly state which stage of recovery participants were in and the average age of participants varied from 62.3 (Page et al., 2005) to 72.7 (Liu et al., 2004a) years old. Overall, most studies on the use of imagery during stroke rehabilitation have used chronic stroke patients but, as in the Liu et al. (2004a) study cited above, some research with acute stroke patients has started to emerge. Further research is needed to discover whether participant characteristics such as time post-stroke and age alter the effect of imagery on movement performance.

2.4.2 Instructions given by experimenters during imagery interventions. Few studies that investigate the use of imagery during stroke rehabilitation include information regarding what instructions the experimenters give participants prior to and during imagery interventions. This lack of information makes it hard to evaluate imagery delivery and prevents replication of the imagery intervention. The study by Liu et al. (2004a) did include an experimental protocol for the use of imagery that explained every step of the intervention. Unfortunately, the imagery protocol did not include the instructions given to participants. For example, stage five of the protocol involved having participants image their own performance with the aid of picture cards in the correct sequence. Nevertheless, there was no indication in the protocol whether participants were asked to close their eyes during imagery and whether they were asked to focus on the feeling of the movement (kinaesthetic) or the visual image.

In contrast, the study by Dunsky et al. (2008) included the imagery intervention scripts containing the exact instructions that the participants received from the experimenters. The participants were asked to close their eyes whilst imaging and to imagine that they could see and feel themselves walking. The participants were also told in what environment they should visualise themselves. The participants were told that where they were walking there were trees and greenery. Dunsky et al. (2008) may have been trying to relax their participants by asking them to imagine trees and greenery. Imagery sometimes includes relaxation training to try to reduce arousal levels prior to sporting competitions (Hale, 2005). However, when imagery is not used for relaxation purposes, but to improve physical performance, it is advisable to imagine the task in the environment it would normally be performed (Holmes & Collins, 2001). The imagery would then become personalised to the participants and include images of how the physical task is usually performed. Unfortunately, there is no supporting evidence in the stroke literature that imagery has a larger effect on movement when performed in the environment it is normally used, compared to a standard treatment room. Also by asking participants to image a generic countryside scene when walking, the imagery intervention used by Dunsky et al. (2008) was not personalised. A very commendable aspect of this study was the extended length of time of the imagery intervention. Dunsky et al. (2008) asked their participants to perform imagery for 15-20 minutes three times a week for six weeks. Duration and frequency of imagery interventions differ in the literature, sometimes being very brief. This will be discussed in the next section.

2.4.3. Duration and frequency of imagery interventions. The duration of imagery interventions differs in different disciplines. Schuster et al. (2011) investigated the use of imagery in education, medicine, music, psychology and sports. They found that imagery sessions were longer during stroke rehabilitation than the four other categories.

Imagery interventions might be longer in duration during stroke rehabilitation because following a stroke motor cognition and motor performance slow down (González, Rodríguez, Ramirez, & Sabaté, 2005), resulting in stroke-affected individuals taking longer to think about and perform tasks. The time it takes to image an action is similar to the time needed for actual execution; this is known as isochrony (Mulder, 2007). Therefore, stroke-affected individuals would then require longer time to image tasks effectively.

Variations in imagery duration have also been found within the stroke rehabilitation literature. In the study by Page et al. (2001a) imagery was performed for 10 minutes, while the imagery intervention by Simmons, Sharma, Baron, & Pomeroy (2008) lasted 70 minutes. There were also variations in how often imagery was performed throughout a week and how long the imagery intervention lasted for. Only one imagery session was conducted in the study by Malouin, Richards, Doyon, Desrosiers, & Belleville (2004), but imagery was performed everyday by Dijkerman, Ietswaart, Johnston, & MacWalter (2004). The longest imagery intervention is six weeks, which was performed by several studies such as Dunsky et al. (2008) and Page et al. (2007). The literature review by Schuster et al. (2011) found that imagery interventions, with positive results, on average involved imagery three times a week for 17 minutes.

2.4.4. When and where imagery interventions are performed. Similar to duration and frequency of imagery interventions, there have also been differences reported in the literature regarding when and where imagery should be performed. A literature review by Malouin et al. (2013) found that imagery interventions fell in to one of three modes of delivery. The first two modes of imagery delivery combined imagery with physical therapy. The first mode performed imagery after the physical therapy session while the second mode performed imagery during the physical therapy sessions. The third mode of imagery delivery did not include physical therapy during the imagery intervention. Most of the imagery interventions were combined with physical practice (21/27), with only six studies performing imagery independently.

Malouin et al (2013) found imagery interventions without physical practice in subacute patients did not yield better outcomes than usual therapy (Dunsky et al., 2008; Ietswaart et al., 2011; Timmermans et al., 2013). In contrast, research by Crajé, van der Graaf, Lem, Geurts, and Steenbergen (2010) found when imagery was performed without physical therapy for three weeks improvements were found in reach, grasping and hand dexterity movements. This could be because the imagery intervention conducted by Craje et al. (2010) focused on movements occurring in the upper-limb, such as reaching and grasping. In contrast, the imagery intervention by Dunsky et al. (2008) focused on walking and imagery of ADL was conducted by Ietswaart et al., (2011). It is possible that when imagery is performed to improve walking and ADL post-stroke, physical practice is also required as the lower-limb muscles are larger than the upper-limb muscles (Saladin, 2004). The larger lower-limb muscles require a greater amount of muscle activation to produce movement than the upper-limb muscles (Kern, Semmler, & Enoka, 2001). Therefore, the performance of imagery without physical practice may be beneficial at improving upper-limb movements. However, when imagery is used to improve walking post-stroke, imagery should be combined with physical practice. Significant gains in motor activity have also been found following a two week imagery intervention that did not include physical therapy and focused on a reach and grasping task (Crosbie, McDonough, Gilmore, & Wiggam, 2004). The results of the Crosbie et al. (2004) study highlighted that imagery may be more effective when only one task is trained and at a high intensity (e.g., every day).

Malouin et al. (2013) did not conclude whether imagery interventions performed during physical therapy were more beneficial at improving movement than imagery performed after physical therapy. This could be because imagery has been found to improve movement when performed during (Liu et al., 2004a) and straight after (Page, 2000) physical performance. It is likely that performing imagery during and straight after physical practice would increase the vividness and the kinaesthesis of the imagery as the movement is fresh in the participant's mind. However, further research is needed to determine whether imagery is more effective at improving movement when performed during, straight after or without physical practice.

Imagery interventions in stroke rehabilitation are performed both at home and at hospital. Research in the sporting literature suggests that imagery is more effective when performed in the same environment as physical practice (Callow et al., 2006; Smith et al., 2007). Lang's (1979) bio-informational theory suggests that imagery should be personalised and multisensory involvement of the individual is needed to generate the image content. This implies that imaging in and of unfamiliar environments might not be optimally effective, as imagery in familiar settings should help to access the correct motor representations of already existing neural connections and provide environmental cues (Holmes & Collins, 2002). Therefore, imagery during stroke rehabilitation would be beneficial if performed where the imaged tasks would normally occur. For example, imagery of reaching and grasping a cup should be performed in the kitchen at home or at least whilst sat at a table, as this is where the task is likely to normally be performed. Further research is needed to investigate the effects of the environment on the effectiveness of imagery in stroke rehabilitation.

2.4.5. Combining imagery with other therapies to improve imagery effectiveness. Imagery has also been combined with other therapies such as physical practice (Hewett et al., 2007) and task sequencing analysis (Liu et al., 2004a) in an attempt to improve its effectiveness. Research by Hewett et al. (2007) supported the idea that imagery can be beneficial in stroke rehabilitation. The study found that following a six week imagery intervention, which also included physical practice of the imaged ADL, reach-out and reach-up performance significantly improved in individuals affected by stroke. Page (2000) found that when imagery was combined with occupational therapy, scores on the upper-extremity section of the Fugl-Meyer Assessment of Sensory Recovery (FMA; Fugl-Meyer, Jaasko, Leyman, Olsson, & Steglind, 1975) significantly improved in chronic stroke patients. Imagery has also been found to reduce impairment and improve outcomes in acute stroke patients when combined with occupational therapy (Page et al., 2001a).

Liu et al. (2004a) also found improvements in the performance of daily tasks following a three week imagery intervention. In this study the imagery intervention was performed during a physical therapy session, but it is unknown whether the imagery was performed straight before, during or after physical task performance. The imagery also had a strong cognitive emphasis. Patients were required to analyse task sequences and partake in problem identification. It is questionable to what extent task analysis and problem identification can be considered as imagery. If imagery is more effective at improving motor and movement performance when combined with physical practice, task analysis and problem identification (Dijkerman et al., 2004; Liu et al., 2004a), then imagery should be used in this manner during stroke rehabilitation. Currently it is unknown whether this is the case. More research is needed to examine this.

Imagery on its own may not be effective at improving movement without physical practice. Research by Ietswaart et al. (2011) did not report enhancements to motor recovery in acute stroke patients following a four week imagery intervention. The imagery intervention used by Ietswaart et al. (2011) also included mirror box therapy and action observation, but did not include physical practice. No difference was found between the baseline and treatment group on the Action Research Arm Test (ARAT). Dunsky et al. (2008) also found that imagery did not affect motor abilities of the lower and upper-limbs when performed without physical practice, as shown by FMA scores. Reasons for the studies by Ietswaart et al. (2011) and Dunsky et al. (2008) not finding improvements in motor recovery following the use of imagery could be because the ARAT and FMA only detect gross movement changes. There could have been improvements to patients' fine dexterity that were not detected by the ARAT and FMA.

Ietswaart et al. (2011) also claimed that their findings disprove the suggested idea that brain plasticity is the underling mechanism for improvement in movement following imagery (Robertson & Murre, 1999). Ietswaart et al. (2011) suggested that the benefits of imagery that have previously been found by Dijkerman et al. (2004) are essentially due to combining physical and imagery practice. This indicates the need for further research comparing the neurological changes between imagery without physical practice and imagery with physical practice. Dijkerman et al. (2004) have previously found that combining imagery with physical practice only improves trained tasks. The combining of physical and mental practice reactivates recently used motor representations allowing for an increased effect of physical practice. However, this implies that the benefit of imagery is not independent of physical practice and imagery would not form an alternative if physical practice were not possible (Sharma, Pomeroy, & Baron, 2006). Ietswaart et al. (2011) stated that it remains to be seen whether imagery is a useful rehabilitation technique for stroke.

2.5. Summary of imagery literature

Overall the use of imagery is a simple and inexpensive therapy that can potentially improve movement following stroke. Variations in the effects of imagery occur in the literature because of differences in study method and imagery content. Identifying which imagery methods are more effective at improving movement would enable guidelines to be produced regarding the use of imagery during stroke rehabilitation.

2.6. Mirror box therapy: An examination of the effects of mirror box therapy on motor cortex excitability

Another therapy that could potentially aid in the recovery of movement is the use of a mirror box. In healthy adults, the visual stimulation from the mirror during mirror box therapy has been found to activate the ipsilateral primary motor cortex when performing a unilateral hand movement. The ipsilateral primary motor cortex has been reported to be active during voluntary unilateral arm and hand movements (Liepert, Dettmers, Terborg, & Weiller, 2001). However, the mechanisms behind the effects of mirror box therapy during stroke rehabilitation still remain unclear. Research by Touzalin-Chretien and Dufour (2008) found no effect of mirror box therapy on motor cortex excitability in healthy individuals, and they suggested that mirror box therapy needed to be combined with imagery in order to increase motor cortex excitability. Michielsen et al. (2010) found that mirror box therapy did not increase motor cortex excitability in stroke patients but there was activation in the precuneus and the posterior cingulate cortex (that regulate awareness of the self and spatial attention).

2.6.1. The use of mirror box therapy in the treatment of phantom limb pain. Prior to mirror box therapy being used with individuals-affected by stroke to provide neural stimulation to help improve movement (Michielsen et al., 2010); mirror box therapy was used by Ramachandran (1994) in the treatment of phantom limb pain after amputation. Through the movement of the intact limb, mirror box therapy gave the illusion that the phantom arm was moving. Patients moved their intact limbs into a position that they found uncomfortable while looking at the reflection in the mirror. They then gradually relaxed into a position that they found comfortable and noticed that the phantom limb pain decreased. Additional research confirming the effectiveness of this therapy was performed by Chan et al. (2007), who found mirror box therapy that was performed with arm amputees for 15 minutes every day for four weeks reduced phantom limb pain.

Mirror box therapy during stroke rehabilitation involves the performance of bilateral arm movements while the impaired limb is obscured from sight by the box. The patient watches the movement of the unimpaired limb in the mirror reflection, thus giving the illusion that the impaired limb is moving unaffected with enhanced movement capability. An advantage of mirror box therapy is that it is easy to administer, enabling patients to self-administer the therapy at home.

2.7. Mirror box therapy in stroke rehabilitation

2.7.1. The effect of mirror box therapy on motor recovery post-stroke. Even though it is unclear what the mechanisms are behind mirror box therapy, researchers have reported improvements in movement both in the upper and lower extremities. Yavuzer et al. (2008) found that a four week mirror box and conventional rehabilitation programme in sub-acute stroke patients produced significant improvements in Brunnstrom stages for the hand and upper-extremity and the Functional Independence Measure (FIM) self-care score. Sütbeyaz, Yavuzer, Sezer, and Koseoglu (2007) conducted a study into the use of mirror box therapy with 40 patients with lower-extremity hemiparesis. Participants were assigned randomly to either a mirror box or control group. Participants in the mirror box group showed significant improvement in Brunnstrom stages and FIM motor scores, but the control group did not significantly improve. Altschuler et al. (1999) also found substantially more stroke-affected individuals improving range of motion, speed and accuracy of upper-limb tasks following mirror box therapy than following the use of a transparent plastic sheet. Participants were also asked to comment on their mirror box therapy experience. All participants mentioned that they preferred to use the mirror box therapy than the clear plastic as the mirror box felt more helpful. One participant commented that while other therapy methods exercise the individual's muscles, the mirror box is the only method that exercises the brain and nerves. These comments emphasise that stroke-affected individuals like to perform therapies that they know can help improve their movement and that they can perform by themselves, thus allowing them to take control of their own rehabilitation.

Thieme, Mehrholz, Pohl, Behrens, and Dohle (2012) conducted a review into the effect of mirror box therapy for improving motor function after stroke. They reported that mirror box therapy significantly increased the performance of activities of daily living (ADL). Four studies (Cacchio, de Blasis, de Blasis, Santilli, & Spacca, 2009; Michielsen et al., 2011; Sütbeyaz et al., 2007; Yavuzer et al., 2008) have shown that mirror box therapy also has a lasting effect on motor function, with improvements lasting six months after the intervention. Thieme et al. (2012) also reported that mirror box therapy significantly reduced pain in patients after stroke. However, the results of Thieme et al. (2012) are limited because when calculating the effect of mirror box therapy, standardised mean difference was calculated from post intervention and follow-up means only. By not taking away baseline data from the post intervention data the effect of mirror box would most likely have been inflated. This is because participants might not have started with a zero score prior to intervention. A thorough meta-analysis is needed, taking into consideration pre-intervention scores, to give a truer representation of the mirror box therapy literature during stroke rehabilitation.

When looking at the results of the mirror box studies mentioned so far, not taking into account the questionable review by Thieme et al. (2012), it appears that mirror vision feedback does not stimulate the motor cortex but does substantially aid recovery of individuals affected by stroke. The physical practice that occurs during mirror box therapy is likely to be the dominant factor that causes improvements in movement. Patients may be more motivated to take part in mirror box therapy than physical therapy, since the visual stimulation from the mirror gives the illusion that the affected arm is moving unaided. A participant in a mirror box study by Altschuler et al. (1999) commented that he liked using the mirror as "it looks like my bad arm is moving normally" (p. 2035) even though it was not.

Progression and improvement of motor recovery following mirror box therapy did not occur in all participants during the studies by Altschuler et al. (1999) and Sütbeyaz et al. (2007). The variability in results suggests that mirror box therapy may aid some patients more than others. This could be because of lesion location and duration of paralysis following stroke. A greater understanding of these aspects could possibly help therapists when determining which patients are likely to benefit most from mirror box therapy. However, as mirror box therapy is a simple and inexpensive procedure there is no reason why it could not be administered routinely in addition to physiotherapy and occupational therapy sessions.

2.8. Summary of mirror box therapy literature

Even though there is evidence that mirror box therapy can aid stroke rehabilitation it is not included in the National Clinical Guideline for Stroke (2012). Without any clinical guidelines on how to implement mirror box therapy therapists might not use it during their current clinical practice. It would be beneficial to investigate whether therapists think that mirror box therapy should be used during stroke rehabilitation, if therapists are implementing mirror box therapy and if so how. It would also be useful to know whether therapists have observed any benefits following its use. If therapists are using mirror box therapy, knowing how they implement this technique would facilitate in the production of clinical guidelines. Clinical guidelines would help standardise therapy care enabling stroke-affected individuals to receive the most effective mirror box therapy. During mirror box therapy, patients observe their non-affected limb in a mirror. It could be questioned however, whether it was actually action observation that aided movement improvement or the physical practice that occurred during mirror box therapy. The effects of action observation on movement improvement will be discussed in the next section.

2.9. The use of action observation

Action observation has been shown to play a role in learning or re-learning motor tasks (Gatti et al., 2013). Action observation is the observation of movements with the intent to imitate (Pomeroy et al., 2005). Action observation increases cortical excitability of the primary motor cortex (Gangitano, Mottaghy, & Pascual-Leone, 2001), as well as involving cognitive processes such as understanding the actions and intentions of others (Iacoboni et al., 2005), motor memory formation (Stefan et al., 2005) and imitation learning (Iacoboni et al., 1999). Humans are able to imitate a movement after it has been observed. Imitation enables the acquisition of new skills and could aid in the relearning of movement patterns and behaviours that are affected following a stroke (Mulder, 2007).

A large quantity of neuroscience research now indicates an interrelation between common sensory and motor processes, specifically regarding action perception, motor imagery and movement execution. The potential relevance of these findings has been highlighted by Holmes, Cumming, and Edwards (2010) as a way of improving methods in movement rehabilitation. During observation of an action of another person or oneself, not only visual-conceptual areas of the brain become activated, but also motor cortical areas that are typically involved in action execution. This motor cortical involvement assists simulation of the observed action by the observer (Jeannerod, 2001; Keysers & Gazzola, 2007) and primes motor execution (Heyes, 2011). Motivated by the original demonstration of 'mirror neurons' in the macaque monkey, that fire during both action observation and execution (Rizzolatti & Fadiga, 1998), over the past decade a large number of brain imaging studies have demonstrated that humans' action observation also engages motor regions of the brain, a so called human mirror neuron system (hMNS). Action observation can facilitate basic motor parameters such as force production (Porro et al., 2007) as well as more complex imitation learning (Vogt et al., 2007; Vogt & Thomaschke, 2007). A meta-analysis of 87 brain imaging studies on action observation and imitation has recently been provided by Caspers, Zilles, Laird, and Eickhoff (2010), confirming the consistent involvement of BA44, bilateral premotor and inferior parietal regions in observation and imitation, which is also called the 'fronto-parietal mirror circuit' (Rizzolatti & Sinigaglia, 2010).

These findings suggest new ways to consider stimulating motor weakness, regeneration and plasticity using action simulation procedures when function of these structures has been compromised by stroke. A number of related reviews have therefore proposed the potential of action observation and motor imagery in motor rehabilitation (de Vries & Mulder, 2007; Garrison, Winstein, & Aziz-Zadeh, 2010; Holmes, 2007, 2011; Mulder, 2007) as an alternative or complement to physical therapy. Pomeroy et al. (2005) suggested that action observation would be beneficial during stroke rehabilitation because observation of movements with the intent to imitate produces activity in motor neurons and paretic muscles that would be required to perform the observed action. During action observation with healthy individuals muscle activation only occurs in the muscles that are active during the observed physical movement (Urgesi, Candidi, Fabbro, Romani, & Aglioti, 2006). However, more research is needed with individuals affected by stroke to determine how brain activation is affected during action observation post-stroke.

2.10. Action observation during stroke rehabilitation

Following a stroke many individuals are left with motor impairments, cognitive and psychological disabilities that might continue for many years post-stroke. Increasing opportunities for neuroplastic adaptions to occur through action observation could improve rehabilitation outcomes following a stroke (Pomeroy et al., 2005). Recent research has focused on using imagery to achieve neuroplastic change (Page et al., 2005). However, Holmes (2007) has identified a number of practical and theoretical problems with performing imagery during stroke rehabilitation. These problems include difficulties with patients' ability to generate clear images and the context and control of imagery interventions in the literature. Therefore, action observation might be a possible adjunct (or even alternative) to imagery during therapy sessions. Action observation of meaningful actions could possibly provide stroke-affected individuals with a multi-sensory experience that is not as easily controlled in imagery interventions (Holmes, 2007).

Until recently action observation interventions through video recordings have been problematic in regards to cost, size of equipment, technical understanding of hardware and editing software (Holmes, 2011). The developments in digital media allow quick and easy production of high definition images, in the same orientation as physical performance and in a first person visual perspective. Action observation through video recordings enables people affected by stroke to conduct action observation independently, without a therapist, in their own home. This enables stroke-affected individuals to take control of their own therapy and keep themselves active so that physical performance does not decrease in-between therapy sessions.

2.10.1. The effect of action observation on motor recovery post-stroke. A combination of action observation and physical therapy of daily actions over four weeks has been found to significantly improve motor function of the upper-limb and produced a reorganisation of the motor system (Ertelt et al., 2007). In this study each action observation session lasted 90 minutes. Participants first observed an action on a television for six minutes then physically practiced the actions they had just watched for a further six minutes. During each therapy session participants observed three hand movements and three arm movements that increased in complexity. Participants received 18 therapy sessions on 18 consecutive working days. Improvements in motor function were measured with the Frenchay Arm Test (FAT; de Souza et al., 1980), Wolf Motor Function Test (WMRT; Wolf, Lecraw, Barton, & Jann, 1989) and the Stroke Impact Scale (SIS; Duncan et al., 1999). Significant improvements in motor function following a 4 week intervention of action observation combined with physical therapy have also been found by Franceschini et al. (2010). The action observation intervention occurred five days a week and included the observation of video-clips of daily hand actions, followed by the imitation of those same actions by chronic stroke patients. Therefore, regularly combining physical practice and observation of ADL can help improve motor function.

A case study by Chatterton et al. (2008) highlighted the importance of action observation being personalised to the patient. Time Up and Go (TUG) scores increased following the 12 week action observation intervention. During the intervention the participant was required to perform action observation for 15 to 20 minutes, twice a day. Personalised action observation keeps participants engaged, as they are interested in the tasks they are observing, which motivates them to improve their performance of the observed tasks.

To determine whether action observation reorganises the motor system functional magnetic resonance imaging (fMRI) was used in the study by Ertelt at al. (2007). When the fMRI scans were taken participants manipulated different objects in both their affected and unaffected hands. Following the intervention activation levels increased in large areas of the sensorimotor network when manipulating objects in both the affected and unaffected hand, indicating that action observation helps reorganise the motor system in people affected by stroke.

2.10.2. Image perspective and image orientation of observed actions. Only recently, the development of new technology has allowed good quality recordings to be produced of ADL from a first person visual perspective (Holmes, 2011). Action observation from a first person visual perspective may be more beneficial than from a third person visual perspective when performed within meaningful contexts. This is because a first person visual perspective is more tightly coupled to the sensory-motor system than a third person perspective (Maeda, Mazziotta, & Iacoboni, 2002). Research by Ewan et al. (2010a) found first and third person visual perspective action observation of meaningful behaviours improved motor function. However, more research is needed to compare the effectiveness of performing action observation from a first or third person visual perspective or a combination of both perspectives.

As well as image perspective, image orientation during action observation has been investigated. The effect of the orientation of observed limbs and manipulated objects on motor memory formation has been investigated by Celnik, Webster, Glasser, and Cohen (2008). They found that motor memory formation was greater with a combination of physical therapy and congruent action observation (performed and imaged actions in the same direction), than physical therapy alone, or physical therapy and incongruent action observation (performed and imaged actions approximately in opposite directions). This could be because in healthy individuals Maeda, Kleiner-Fisman, and Pascual-Leone (2002) found that congruent action observation produced significantly more brain activation than incongruent action observation. Greater brain activation could help facilitate the learning of new tasks (Hubli & Dietz, 2013). However, it is unknown whether congruent action observation increases brain activation in stroke-affected individuals. The results of Celnik et al. (2008) indicate that during action observation interventions, observed actions should be in the same orientation and direction as physical performance, to enhance motor training after stroke. As well as improving motor memory formation post-stroke, action observation can help enhance motivation (Ewan et al., 2010a).

2.10.3. The effect of action observation on patients' motivation. Following a stroke it is important that patients remain motivated. Ewan et al. (2010a) found that a programme of action observation including meaningful motor behaviours served as a motivating agent to (re)engage individuals affected by stroke in activities they believed that they could no longer perform. Observing activities that patients used to enjoy helped remind them that life does continue after stroke and there are tasks they can still perform. The action observation programme positively affected participants' psychological wellbeing and motor function.

2.11. Summary of action observation literature

Action observation does not solely occur through the use of video recording but also by observing other individuals' movements. It is unclear whether therapists realise that during demonstrations neural activation is occurring in the patients, through action observation. When demonstrating, therapists need to make sure that patients are actively observing with intent to physically replicate the observed movement. As with mirror box therapy, action observation is not included in the National Clinical Guideline for Stroke (2012). Knowing whether and how therapists conduct action observation would aid in the development of clinical guidelines. Following a stroke patients might not be motivated to partake in physical activity. This could be because a patient's disability makes certain movements difficult. However, patients might want to watch video clips of movements they wish to improve. Research by Ewan et al. (2010a) found that action observation increased patients' motivation and helped (re)engage them in activities they thought they could no longer perform.

2.12. Motivation during stroke rehabilitation

Motivation is seen by health professionals as being a key factor in the rehabilitation process and can affect rehabilitation outcomes (Maclean, Pound, Wolfe, & Rudd, 2002). A patient's level of motivation is very important when partaking in rehabilitation because motivation is the direction and intensity of an individual's effort (Sage, 1977). If an individual has low levels of motivation, he or she will exert low levels of effort, therefore reducing the effect of the rehabilitation. A lack of motivation is one of the key issues associated with stroke, as it might make attempts at rehabilitation ineffective.

Occasionally in the literature, the term depression is used incorrectly to describe a lack of motivation. During the first year following a stroke at least one third of patients become depressed (Hackett, Yapa, Parag, & Anderson, 2005). Individuals can become depressed following a stroke because they are unable to cope with their disabilities, related changes to their personal and social lives and are experiencing pain

(Carson, Ringbauer, Mackenzie, Warlow, & Sharpe, 2000). Depressed patients have been reported to be substantially more disabled (Carson et al., 2000). Depression has been reported by Robinson, Bolla-Wilson, Kaplan, Lipsey, and Price (1986) to impair physical and cognitive function and can increase stress on carers (Anderson, Linto, & Stewart-Wynne, 1995). Patients who suffer from depression appear less responsive to rehabilitation and have a worse long-term prognosis (Astrom, 1996). Research by Maclean and Pound (2000) found that patients who were highly motivated were responsive to rehabilitation, as they understood that it was necessary for them to play an active role in their rehabilitation. This is why it is vitally important that patients remain motivated during stroke rehabilitation.

2.12.1. Maintaining and enhancing motivation post-stroke. As motivation is a key factor in the rehabilitation process it is important that therapists know how to effectively maintain and enhance motivation.

2.12.1.1. Trait verse interactional view of motivation. Clinical rehabilitation literature tends to conceptualize motivation as a personality trait (Clark & Smith, 1997), but according to the widely endorsed interactional view (Sorrentino & Sheppard, 1978) the environment can affect motivation. Research by Maclean et al. (2002) into stroke professionals' attitudes towards patient motivation discovered that stroke patients' motivation is affected by the rehabilitation environment, as a stimulating ward environment increases motivation.

Cognitive therapies could be used during stroke rehabilitation to provide a stimulating ward environment. Patients could be given a mirror box that they could use by themselves, in-between therapy session, when on the ward. Therapists could provide patients with information regarding how to set up the mirror box and exercises to perform. Patients could also be provided with DVD clips of activities that are performed during physical therapy. This will enable action observation to occur whilst on the ward. Patients could be encouraged to perform imagery in-between therapy sessions with therapists providing guidance on the physical tasks patients could image. Therefore, to enable patients to remain stimulated while on the ward they could perform imagery, mirror box and action observation independently without the therapist.

Maclean et al. (2002) did also mention that medical professionals comfortably categorize patients as being motivated or unmotivated. Classifying whether a patient was motivated or unmotivated affected the way medical professionals treated the patients. Maclean et al. (2002) found that when a patient was classified as unmotivated medical professionals typified patients as being "lazy" (p.446) and that working with them was a chore. This resulted in medical staff not encouraging unmotivated patients, which is counterproductive. Therapists need to be vigilant that they administer cognitive therapies to all patients regardless of their motivational state. Cognitive therapies could potentially help motivate patients by enabling them to feel increased control over their rehabilitation, according to attribution theory (Weiner, 1985). Patients might also experience associated changes in confidence level (Vealey, Hayashi, Garner-Holman, & Giacobbi, 1998). Good confidence levels will help motivate patients to achieve success, set challenging goals, feel in control of their rehabilitation and performance, and increase self-worth leading to enhancements in performance. The results of Maclean et al. (2002) have highlighted the importance of not classifying whether a patient is motivated or unmotivated and that the environment could alter patents' motivation levels.

2.12.1.2. Motivation affects patients' choices of activities. Following a stroke some individuals will not perform tasks that they used to be able to perform competently prior to a stroke as they are attempting to avoid failure, as per the predictions of Atkinson's (1974) Need Achievement Theory (Atkinson, 1974). The Need Achievement Theory has been used in a sporting context to help predict an individual's behaviour. Individuals are either motivated to achieve susses and will strive to enhance performance or aim to avoid failure and avoid challenges. It is unknown in a stroke rehabilitation context whether individuals who are motivated to achieve success recover quicker than someone who wishes to avoid failure. It is possible that the person affected by stroke will not want anyone to see him or her perform poorly. For example, the author has observed a man at the local stroke support group refusing to play magnetic darts because he used to be very proficient, and play in the local darts league. The author felt sad observing him refuse to play a sport that he used to enjoy. Cognitive therapies could be used to engage patients who have a fear of failure. The performance of imagery and action observation does not require physical movement and the movement of the affected limb cannot be seen during mirror box therapy. Therefore, patients could perform cognitive therapies on the ward without feeling embarrassed as no one would know that the patient is unable to perform the physical task. In addition cognitive therapies could help reengage patients by making them want to relearn tasks they used to be able to perform (Ewan et al., 2010a). Action observation could be especially beneficial with patients who are unmotivated to partake in physical therapy, as they might agree to observing ADL. This might lead to patients wanting to physically perform the observed actions.

Mirror box therapy and imagery could also keep patients stimulated and reengage them in physical activity. Mirror box therapy could reengage patients in physical practice as the reflexion of the unaffected limb gives the illusion that the affected limb is performing smooth actions with no impairment. The illusion of the affected limb moving unimpaired might be less upsetting than physical therapy, as patients do not have to observe their impairments during physical practice. Patients also do not observe their physical impairments whilst imaging as no movement occurs. Imagery could be beneficial to motivation as there are no restrictions on what activities can be imaged as all the images are generated in the brain. In addition, patients could quickly change from viewing an activity from a first or third person visual perspective. Patients might want to be able to change imagery perspective quickly as imagery from a first and third person visual perspective both have benefits. Imagery from a first person visual perspective could help patients experience the feel of the imaged movement (kinaethesis) and visualise the environment the task is normally performed in (White & Hardy, 1995). In contrast, imagery from a third person visual perspective could be beneficial when learning movements that require coordination between limbs (White & Hardy, 1995). This is because imagery from a third person visual perspective teaches patients about the form of movements and aids in movement sequencing (Fery, 2003). Imagery, mirror box therapy and action observation could all be performed with individuals who have a fear of failure as the patients physical disability is not easily recognisable. This could stop patients focusing on the movements they cannot perform.

2.12.1.3. The effect of therapists' behaviour on patients' motivation. Maclean et al. (2002) found that stroke patients' motivation could be affected by professionals' behavior. When a therapist's demeanour is happy through smiling, giving verbal complements and using non-verbal behaviours that imply approval (e.g., giving the patient the thumbs up) patients motivation will probably increase (Smith & Smoll, 1997), while a therapist who has low expectations of a patient's performance decreases motivation. When implementing cognitive therapies therapists need to convey a happy demeanour and give verbal encouragement (Smith & Smoll, 1997). Verbal encouragement also needs to include knowledge of performance to provide patients with specific feedback regarding correctness of performance. Therapists are said to increase motivation by setting relevant rehabilitation goals, providing information about rehabilitation and providing encouragement (Maclean et al., 2002). This is in agreement with research on motivation in the sport literature (Kyllo & Landers, 1995; Biddle, Hanrahan, & Sellar, 2001).

2.12.1.4. The use of goal setting to increase motivation post-stroke. During cognitive therapies, therapists could include task orientated goals to increase patients' motivation. Task orientated goals provide individuals with greater control over goal accomplishments, resulting in patients persisting longer when failure is close (Rensick et al., 2009). During rehabilitation the goal setting process normally consists of four aspects, which are: (1) involvement of the patient and family members; (2) formal assessment of the patient's ability; (3) creation of goals; and (4) the patient and family are educated in the use of goals (Leach, Cornwell, Fleming, & Haines, 2010). The patients' disability level affects the degree of involvement the patient and family have in developing goals and suggesting tasks to be performed during cognitive therapies. For example, a therapist-led approach is adopted when patients have communication problems (Playford et al., 2000). This is because patients are often ashamed of their disability or modest in their attempts to suggest appropriate goals, resulting in therapists devising the goals (Playford et al., 2000).

Following goal generation therapists educate patients and family about what they hope to achieve through rehabilitation, what they could expect along the path of rehabilitation and how they could be reintegrated into society when they have left hospital (Leach et al., 2010). Education during rehabilitation significantly increases the effectiveness of the collaboration between the patient and therapist, which is fundamental to the setting of realistic and achievable goals (McAndrew, McDermott, Vitzakovitch, Warunek, & Holm, 1999). If patients are not educated about the goal setting and rehabilitation process decreased motivation may occur when patients are trying to achieve outcomes (Hafsteinsdottir & Grypdonck, 1997).

2.13. Summary of motivation literature

Cognitive therapies could potentially help patients to remain motivated during their stroke rehabilitation by providing a stimulating environment and helping to reengage patients to participate in physical practice. However, no research has been conducted into therapists' views on the use of cognitive therapies to increase motivation and if or how they use these therapies to increase stroke patients' level of motivation. If therapists can motivate stroke patients to partake in cognitive therapies then patients will likely exert more effort (Sage, 1977) during rehabilitation sessions.

2.14. Aims and objectives of the MPhil studies

Despite some of the shortcomings and conflicting results in the literature, imagery still appears to be a beneficial treatment option. This is because imagery is perceived by practitioners to be easy to learn and apply, not psychologically harmful or exhausting and inexpensive (Pomeroy et al., 2005). However, there is a lack of clarity as to whether or not imagery provides a significant advantage over rehabilitation that solely uses physical practice of tasks. Systematic reviews do not tend to focus on the effect of imagery on movement performance. It is important to know whether imagery can facilitate improvements in movement during stroke rehabilitation. Therefore, a meta-analysis was conducted to quantify the effects of imagery during stroke rehabilitation.

There is also evidence that mirror box therapy and action observation can aid stroke rehabilitation as well as imagery. It is not known whether and to what extent physiotherapists and occupational therapists use these therapies in their current practice and how they use them. Investigating this issue will give an insight into how therapists perceive the usefulness of cognitive therapies in stroke rehabilitation and whether they require more research before using them in their current practice. The potential issues and problems in therapists' use of cognitive therapies will help inform and enable the production of clinical guidelines on the use of imagery, mirror box therapy and action observation during stroke rehabilitation.

The aims of the MPhil studies were to:

1. Quantify the effects of imagery on upper- and lower-limb movement ability post-stroke, through the use of meta-analytic techniques;
2. Conduct a national skill audit to investigate the extent to which physiotherapists and occupational therapists in the UK use imagery, mirror box therapy and action observation during stroke rehabilitation, to discover how these are conducted and also to explore therapists' views;
3. Examine how physiotherapists and occupational therapists motivate stroke patients through the use of cognitive therapies.

Due to the exploratory nature of both the meta-analysis and the skill audit, hypotheses were not stated. Aim one was addressed in chapter three and aims two and three were addressed in chapter four.

Chapter Three: Study One

The Effect of Imagery on Improving Upper and Lower-Limb Movement Ability Post-Stroke: A Meta-Analysis

3.1. Introduction

3.1.1. Previous systematic literature reviews on the effect of imagery during stroke rehabilitation. The effectiveness of imagery in improving movement ability post-stroke has attracted the attention of numerous researchers and, as the literature has evolved, researchers have strived to evaluate the effects of imagery through systematic reviews. Systematic reviews are research into a specific topic through the identification of relevant studies, a summary of their findings and the integration of existing knowledge into a coherent whole (Burns, 2000). To date, published reviews have examined the use of imagery during stroke rehabilitation, for example, the Cochrane Reviews conducted by Barclay-Goddard, Stevenson, Poluha, and Thalman (2011) and Pollock et al. (2014). These have found some encouraging evidence for the effectiveness of imagery in stroke rehabilitation but it is important to note that the review findings have varied greatly. While positive effects were found in studies that used standardised tests of motor performance (Hewett et al., 2007; Page, 2000) and performance of household tasks (Liu et al., 2004a), Ietswaart et al. (2011) and Dunsky et al. (2008) found that imagery did not improve motor recovery post-stroke. Systematic literature reviews have identified variations between studies regarding study methods, imagery session duration and frequency and imagery intervention duration and suggest that such variations make it difficult to compare study findings (Malouin, Jackson, & Richards, 2013; Zimmermann-Schlatter, Schuster, Puhan, Siekierka, & Steurer).

During the study by Page (2000), the imagery sessions took place directly after physical therapy in a separate room, and at home, while Liu et al. (2004a) combined imagery and physical practice at the same time as well as recording participants' performance and identifying faults. When patients watched their performance, action observation occurred so the intervention was a combination of imagery and action observation. The duration and frequency of imagery sessions and the duration of imagery interventions has also been reported to vary greatly (Barclay-Goddard et al., 2011; Bell & Murray, 2004; Braun et al., 2006). Zimmermann-Schlatter et al. (2008) found imagery duration varied from 10 minutes (Page et al., 2001a) to 60 minutes (Liu et al., 2004a) and that frequency of imagery varied between two imagery sessions a week (Page et al., 2007) to one session every day (Dijkerman et al., 2004). Imagery interventions varied in duration from one session (Malouin et al., 2004) to six weeks (Dunsky et al., 2008). As a result, Barclay-Goddard et al. (2011) concluded that there was no clear pattern between studies regarding the ideal dosage of imagery required to improve movement.

Participant inclusion and exclusion criteria also varied greatly between studies. Barreca et al. (2003) found that the most common participant exclusion criteria were severe cognitive deficits and receptive aphasia, the inability to understand written or spoken speech. In addition, Braun et al. (2006) reported that inclusion and exclusion criteria have included varied restrictions regarding age, recovery stage, cognitive and sensory abilities, communication skills, spasticity, pain, type and location of lesion and imagery ability. Prior to participating in an imagery intervention, it is advisable to measure stroke-affected imagery ability (Ietswaart et al., 2011) because the neural circuitries involved in imagery and motor execution, in part, overlap (Munzert & Zentgraf, 2009). The lesion following a stroke could lead to a deficit in motor execution and a reduction in imagery ability when imaging the motor task that is now impaired. Bell and Murray (2004) suggest that level of stroke severity needs to also be part of the patient inclusion criteria since it has been found to affect the benefit of imagery for motor function with little benefit being found when using imagery on well-recovered participants, while patients with significant impairment do benefit (Yoo, Park, & Chung 2001).

Because of variations in study methods, authors of systematic reviews have found it difficult to provide an overall picture of the effectiveness of imagery in post-stroke rehabilitation and to identify the variables that influence the effectiveness of imagery. A significant limitation of the literature reviews conducted by Barreca et al. (2003) and Zimmermann-Schlatter et al. (2008) was that only Randomised Clinical Trials (RCTs) were included so only a small number of studies were considered by both reviews. Barreca et al. (2003) only reviewed two RCTs and both studies were by the same research group (Page, 2000; Page et al., 2001a) while Zimmermann-Schlatter et al. (2008) only included four RCTs (Liu et al., 2004a; Page, 2000; Page et al., 2001a; 2005). One reason for only using RCTs is that they investigate an intervention on a large sample of the population and include a control group, which can identify if an imagery intervention improves motor performance greater than the normal improvements that occur without imagery during post-stroke recovery. During RCTs, participants are either randomly assigned to either the experimental or to a control group and authors are normally concealed from the randomisation process, so that they are unable to place participants who they suspect might recover better following a stroke into the experimental group and thus prevent bias. The randomisation and allocation concealment of participants criteria are outlined by the Amsterdam-Maastricht Consensus List for Quality Assessment (AMCL; Van Tulder et al., 2003). Few RCTs have been utilised in the use of imagery during stroke rehabilitation possibly because they are expensive, require a large amount of resources, large numbers of participants and are time consuming (Bartolucci & Hillegass, 2010). Exploratory studies that have smaller participant numbers are still important as they enable the development of effective interventions, with less cost than RCTs, before investigation on a larger scale.

Another major limitation of systematic reviews is that conclusions reached by researchers after critically evaluating the literature could remain subjective (Burns, 2000) and it is possible that these do not accurately reflect the strength of the relationship being investigated. A meta-analysis could reduce this possibility since it combines quantitative results from separate, but similar studies, through the use of formal statistical methods (Bartolucci & Hillegass, 2010) and thus provides an alternative solution that might enable more definitive conclusions to be drawn. Meta-analyses in the sport psychology literature (Driskell, Copper, & Moran, 1994; Feltz & Landers, 1983), for example, have quantified the overall effectiveness of imagery interventions and identified key variables that determine imagery's effectiveness. It seems, therefore, that findings from a meta-analysis of studies on the effect of imagery on motor performance post-stroke could help inform clinical practice.

3.1.2. Benefits of a meta-analysis. A meta-analysis has two main advantages over a systematic literature review. Firstly, when analysing the literature, a meta-analysis follows and reports a definitive methodology (Thomas et al., 2011). Secondly, a wide variety of dependent variables are being used to measure changes in motor ability since some studies have used scales of movement such as the Fugl-Meyer Assessment (FMA; Page, 2000) while others have used biomechanical analysis techniques such as gait analysis (Hwang et al., 2010). A meta-analysis quantifies the results of different studies, even if they use different dependent variables, because studies are quantified to a standard metric called an effect size, Cohen's d, (1988) categorisation of which enables a determination of whether or not it is meaningful (small = 0.20, moderate = 0.50 and large = 0.80). Bartolucci and Hillegass (2010) see other benefits of a meta-analysis, including the ability of a meta-analysis to detect small, but clinically relevant effects of an intervention, which could possibly be missed during a review. Finally, the diverse nature of participants across all the studies included in a meta-analysis probably facilitates a more global representation of the stroke population.

3.1.2.1. Previous meta-analyses on the effect of imagery during stroke rehabilitation. Prior to the meta-analysis in study one being presented here only three other meta-analyses (Braun et al., 2013; Kho, Liu, & Chung, 2013; Langhorne et al., 2009) had examined motor recovery after stroke. Langhorne et al. (2009) reported imagery to have a positive effect of 0.84 on arm function recovery. However, this meta-analysis was very narrow in breadth and there were several limitations in that: (1) only four studies were included; (2) all these studies focused on arm function; (3) they were all from the same research group (Page, 2000; Page et al., 2001a; 2005; 2007); (4) it is unknown when calculating the effect sizes which dependent variables were included; and (5) publication bias and heterogeneity testing, for example Cochran's Q-Statistic, were not considered. As a result, despite the encouraging findings found by Langhorne et al. (2009), a more comprehensive meta-analysis of the effects of imagery in post-stroke rehabilitation was required.

Comprehensive meta-analyses have more recently been conducted by Braun et al. (2013) and Kho et al. (2013). During the analysis, only studies that used the same dependent variable were pooled together, as they criticised that meta-analyses are unable to compare studies that use different variables (Burns, 2000). Braun et al. (2013) found significant short-term improvements in arm-hand ability (Action Research Arm Test [ARAT]) and improvement in performance of activities (10-point Numeric Rating Scale) from imagery use. Kho et al. also found imagery to facilitate short-term improvements of arm-hand-ability (ARAT*)* and suggested that imagery could be used during motor rehabilitation of the upper-limbs post-stroke. Braun et al. found less positive results than earlier published reviews and that imagery might have positive effects on activity performance in some patients post-stroke.

The methodology used by Braun et al. (2013) was very robust with the inclusion of the AMCL to assess study quality and only pooling data from studies that used the same dependant variables. Therefore, the methodology used by Braun et al. (2013) was adopted as a guide for this study to ensure a rigorous meta-analysis. Potential benefits of a meta-analysis investigating the effect of imagery on movement during stroke rehabilitation could be to inform the optimum delivery of imagery during stroke rehabilitation. A meta-analysis could help indicate whether imagery should be performed with physical therapy and action observation or independently, which Braun et al. (2013) and Kho et al. (2013) did not investigate. They also did not examine optimal imagery content by examining which imagery perspectives, for example, internal, external or both aid movement improvements. A meta-analysis could obtain information regarding optimal imagery session and intervention duration and frequencies. Scrutinising participant inclusion and exclusion criteria could help identify which patients would potentially benefit the most from imagery during stroke rehabilitation.

Imagery appears to be an appealing treatment option. Imagery enables cognitive rehearsal of specific activities when physical performance has been debilitated following a stroke (Pollock et al., 2014). There appears to be mixed views as to whether or not imagery provides a significant advantage over rehabilitation that solely uses physical practice of tasks. Therefore, the aim of this study, as previously stated in chapter two, was to quantify the effects of imagery on upper- and lower-limb movement ability post-stroke, through the use of meta-analytic techniques. As previously mentioned a hypothesis was not stated due to the exploratory nature of the study.

3.2. Method

3.2.1. Literature search. A literature search was conducted of peer-reviewed journal articles, published in English, up until May 2014. Databases reviewed included: The Cochrane Library, Scopus, PubMed Central (UK), PubMed Central (US) and ScienceDirect, EBSCO host including sport discus, PsycINFO, Medline, PEDro, Allied and Complementary Medicine. Search terms were: motor imagery, stroke rehabilitation, movement, mental practice, motor learning, physical therapy, occupational therapy, ADL and mental rehearsal. All sources were collated, reviewed and their reference lists were examined carefully to uncover further sources that were then obtained. An overview of the literature search can be found in Figure 1.

3.2.2. Eligibility criteria. The inclusion criteria stated that: (1) studies had to be conducted in the area of stroke rehabilitation; (2) the treatment investigated was imagery; (3) dependent variables measured movement related improvements in the upper- and lower-limbs; (4) testing occurred before and after the treatment; (5) single-group (groups with no control) and independent groups (imagery and control) designs were used; (6) experimental groups had a minimum of five participants; (7) studies had to provide participant sampling data for all experimental conditions; and (8) studies had to report dispersion data such as group means and standard deviations, or inferential statistics such as independent t-values. Although some studies conducted two pre-treatment testing sessions only the first pre-treatment data were used in the current meta-analysis. Some studies included mid-treatment testing; these data were also excluded from the analysis, as only studies including mid-treatment testing could have been analysed together, resulting in a small number of studies being included in the meta-analysis.

Only studies that investigated the effect of imagery on individuals who had experienced a stroke were included in the meta-analysis. Studies that also included participants with other neurological disorders such as Parkinson’s disease and spinal cord injury were not included, as the thesis is focusing specifically on stroke rehabilitation. Studies were also not included in the meta-analysis if they did not include information regarding dispersion data, as it would not be possible to calculate effect sizes. Initially studies were selected even if they did not have a control group as a mean effect size value could be obtained from studies that included a control condition (Becker, 1988). Subsequently, an average control estimate could then be used where control estimates are missing based on the remaining normally distributed sample of control estimates. However, following the quality screening process, with the AMCL, all the studies that did not have a control group were excluded, as they scored below the cut-off value.

3.2.3. Quality assessment. Methodological quality of the screened studies was assessed using the AMCL. The AMCL includes all the criteria of the Delphi List (Verhagen et al., 1998), which is another prominent quality scales list. The AMCL rates a study’s internal validity and study design. The AMCL rates a study’s quality with an 11-point scale (12 sets of criteria), with a higher score indicating a higher level of quality. When a criterion was fulfilled, a point was awarded, but no point was given when a criterion was not achieved or if it was unclear. A maximum of 11 points could be awarded per study (1 point for items 2-11 and ½ a point for items 1a and 1b).

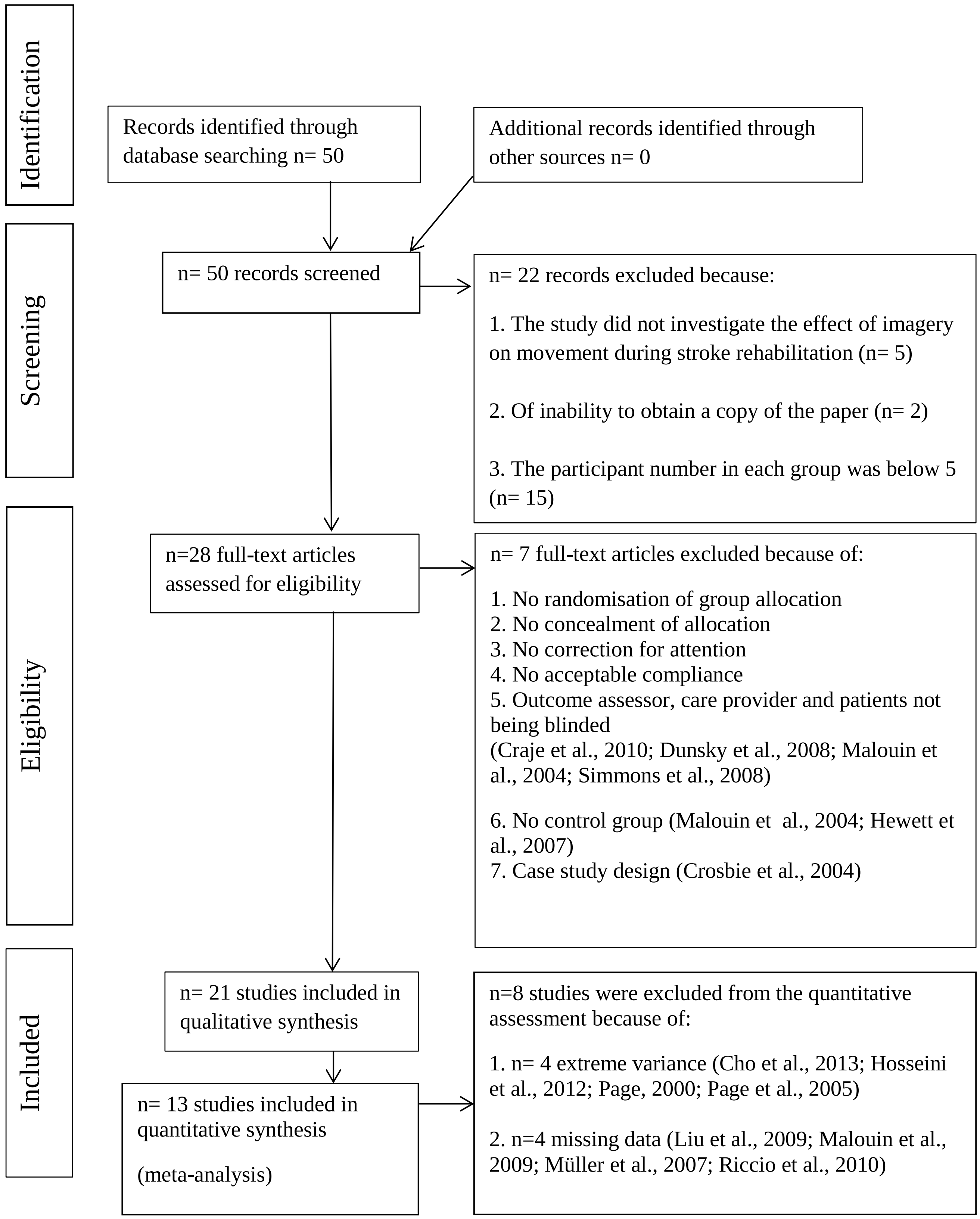


Figure 3.0. Overview of literature search based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

To enable uniformity in the quality assessment process, criteria definitions used by Braun et al. (2013) were applied (see Appendix A). A study was deemed to be of "sufficient quality" if the total score was equal to or above 5.5 points. The cut-off value was decided by the author after taking into consideration values from other reviews in physical therapy (Braun et al., 2013; Van Tulder et al., 2003). The cut-off value used by Braun et al. (2013) was six. However, the cut-off value of this study was reduced to 5.5 because of the nature of the delivery of imagery, specifically that experimenter and patients could not be blind to whether they were delivering or receiving imagery. Also items 1a (randomisation) and 1b (concealment of allocation) only receive half a point. Therefore, a study could include a control group and randomise participants into groups and still be rejected.

3.2.4. Excluded articles. In total 50 studies were found during the literature search but thirteen studies were included in the meta-analysis. Twenty-two studies were excluded during screening because: (1) the study did not investigate improvements in movement; (2) the number of participants was below four; and (3) a copy of the study was unable to be obtained. See Appendix D for a list of excluded articles with exclusion reasons. Twenty-eight studies were assessed for eligibility using the AMCL. The scores on the AMCL ranged from 4 to 8. Seven studies were excluded as they scored lower than 5.5, see Appendix E for details. Four studies were excluded from the meta-analysis because they had missing data (Liu et al., 2009; Malouin et al., 2009; Müller et al., 2007; Riccio et al., 2010). Finally, four studies were excluded because when calculating the exact variance the results were extreme and could not be used in the meta-analysis (Cho et al., 2013; Hosseini et al., 2012; Page, 2000; Page et al., 2005; see Figure 3.0).

3.2.5. Data extracted from primary studies. Data relating to the following design characteristics were recorded: (1) article reference; (2) sampling methods, which included information on sampling numbers, gender, age, time post-stroke, sample selection and distribution across conditions; (3) experimental design, for example single-group or independent groups; (4) dependent variables analysed; (5) treatment characteristics such as type of imagery, duration of the treatment and imagery session duration and frequency; (6) imaged activity; (7) control activity; and (8) dispersion data or inferential statistics. When the data had been extracted from the primary studies they were placed into a spreadsheet to enable orderly storage of the data and comparisons to be made between study designs. The data to be extracted from the studies were decided through the review of data extraction methods by previous meta-analyses (Braun et al., 2013; Kho et al., 2013). After data had been extracted from five studies the data extraction spreadsheet was reviewed. The review focused on whether the correct numeral data (e.g., means, standard deviations and sample sizes) were being extracted to enable the calculations required for the meta-analysis. Also that the data extracted gave a detailed account of the study design used. A sample of the data extraction spreadsheet showing the data extracted from Liu et al. (2004a) can be found in Appendix B.

3.2.6. Statistical procedures. Meta-analyses need to be mindful of publication bias that could favour studies that report significant findings (Leandro, 2005). Analytical correction methods have been devised to calculate the potential impact of publication bias. Rosenthal's (1979) 'File drawer' method was used to calculate the number of unpublished studies with trivial effects that would be needed to reduce the observed treatment effect to a trivial level. Correcting for publication bias is increasingly important, and more so in this analysis, which only included studies from published sources (Cooper & Hedges, 1994). No unpublished studies were uncovered by the data search.

Heterogeneity testing (Cochran's Q-Statistic and I^2-statistic) was used to establish whether the sampled studies were homogeneous. The tests determine whether there are tangible differences between the results of the studies (heterogeneity), or the variation of the findings is consistent with chance (homogeneity; Higgins, Thompson, Deeks, & Altman, 2003). If I^2 was greater than 50% and the Q-statistic reported heterogeneity then a random-effects model was used instead of a fixed-effects model. The same I^2 cut-off value was used as reported by Braun et al. (2013). When the difference between studies is tangible, a random-effects model is used to take into account both within- and between-studies variability (Hedges & Olkin, 1985). The model also determines the weighing factors used to obtain an average effect size (Huedo-Medina, Sanchez-Meca, Marin-Martinez, & Botella, 2006).

A positive bias can occur where study samples are small, for example, less than 20. However, a correction factor was applied to address this issue to produce an unbiased estimate (Hedges, 1989; Hedges & Olkin, 1985). A table of bias correction factor values can be found in Hedges and Olkin (1985).

Pre-test and post-test effect sizes were calculated for every selected dependent variable using the pre-test standard deviation as the denominator in the effect size equation (Becker, 1988). When studies included several dependent variables measuring improvements in movement ability, effect sizes for each dependent variable were calculated, and then an average effect size was used (Rosenthal & Rubin, 1986). Due to the relatively small sample sizes used in most studies an exact variance calculation (Morris, 2000) was used to determine the sampling variance of each within-effect estimate. The resultant within-effect estimates were used to determine the between-participant treatment estimate for each study (Becker, 1988). The variance for the between-participant treatment estimate was established by summing the control and treatment variance values (Becker, 1988). Comprehensive Meta-Analysis (Version 2) computer software was used to produce forest plots. To determine whether the mean treatment effect was meaningful Cohen's (1988) effect size categorisation was used. All the calculations used during the meta-analysis can be found in Appendix C.

A total of 11 meta-analyses were performed. Six meta-analyses investigated the effect of imagery during stroke rehabilitation on physical movement using a different imagery characteristic in each meta-analysis. The imagery characteristics investigated were: (1) any imagery intervention aimed at improving physical movement; (2) imagery performed from a first person visual perspective; (3) imagery performed from a third person visual perspective; (4) imagery performed before physical practice; (5) imagery performed during physical practice; (5) imagery performed immediately after physical practice; and (6) imagery performed without physical practice.

Studies investigating the effectiveness of imagery during stroke rehabilitation use varying measures. There has been criticism in the literature that a meta-analyse is unable to compare studies that use differing measures (Burns, 2010). Therefore, five meta-analyses were performed investigating a different physical outcome instrument. The physical outcome instruments assessed were: (1) ARAT; (2) Gait analysis; (3) ADL; and (4) Barthel Index. In addition to the meta-analyses a Backward Stepwise multiple linear regression was conducted to determine whether age of participants, time post-stroke, duration of therapy, duration of imagery and frequency of imagery could predict the between-participant treatment estimate. A Backward Stepwise method was adopted because the regression was not testing a theory, but was being used for exploratory purposes (Menard, 1995). Also a Forward Stepwise method was not used as it is more likely to cause a Type II error than a Backward Stepwise, as the forward method runs a higher risk of excluding predictors involved in suppressor effects (Field, 2009).

3.3. Results

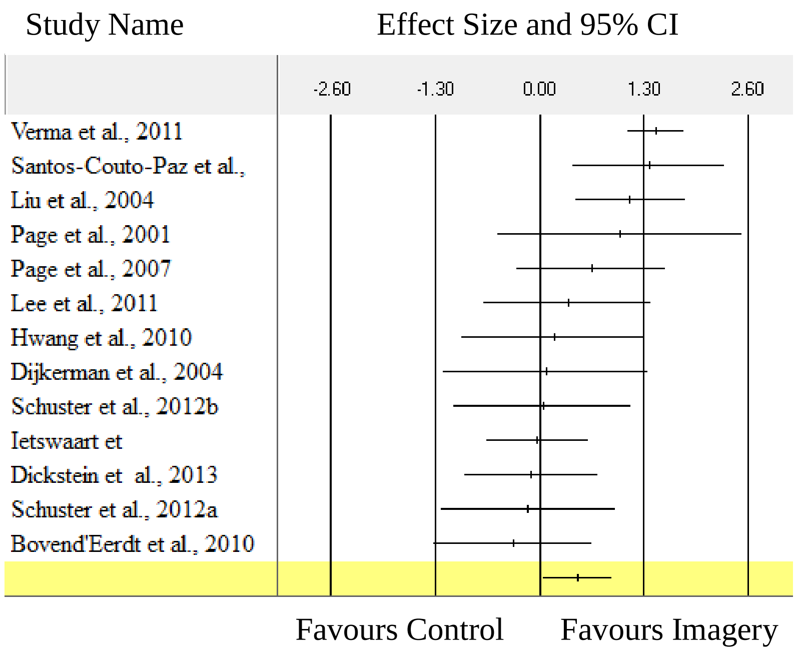
3.3.1. Mean treatment effect. A random effects model was used as the study estimates resulted in a heterogeneous sample (χ^2= 39.36, df= 12, *p*= .00, I^2= 69.51%). Overall the effect size for imagery (*p*= 0.03; *d*= 0.48; 95% confidence interval [CI]: 0.05 to 0.91) was found to have a Cohen's (1988) convention for a moderate effect (*d*= 0.5), see Table and Figure 3.1. The test for publication bias showed that 26 studies with trivial results would be needed to disprove the effect of the imagery treatment reported in this analysis.

3.3.2. Findings of the multiple linear regression, imagery perspective and when imagery was performed meta-analyses. The studies by Dijkerman et al., (2004) and Lee et al., (2011) had to be removed from the multiple linear regression because of missing data. The multiple linear regression found that age of participants (β = -.16), time post-stroke (β = -.14), duration of intervention (β = -.03) and duration (β = - .12) and frequency of imagery (β = .43) did not predict the between-participant treatment estimate ($p > .05$). The predictors also did not explain the significant amount of the variance in the between-participant treatment estimate $F(5,5) = .519$; $p > .05$. The independent variables accounted for 34% of the between-participant treatment estimate.

Table 3.1

Meta-Analysis of the Overall Effect of Imagery on Movement

Study	Effect Size	Standard Error	Variance	95% CI	Sample Size		Weight (%)
					Imagery	Control	
Verma et al., 2011	1.46	0.18	0.03	1.11, 1.81	15	15	11.35
Santos-Couto-Paz et al., 2013	1.37	0.48	0.23	0.42, 2.31	9	9	7.75
Liu et al., 2004a	1.13	0.35	0.12	0.45, 1.80	26	20	9.42
Page et al., 2001a	1.01	0.78	0.61	-0.51, 2.54	8	5	4.86
Page et al., 2007	0.65	0.48	0.22	-0.27, 1.58	16	16	7.85
Lee et al., 2011	0.36	0.54	0.29	-0.69, 1.41	13	11	7.13
Hwang et al., 2010	0.18	0.59	0.34	-0.96, 1.32	13	11	6.61
Dijkerman et al., 2004	0.08	0.66	0.43	-1.20, 1.36	10	10	5.89
Schuster et al., 2012b	0.04	0.56	0.32	-1.06, 1.14	12	14	6.82
Ietswaart et al., 2011	-0.02	0.32	0.11	-0.65, 0.62	41	32	9.70
Dickstein et al., 2013	-0.10	0.42	0.18	-0.92, 0.73	23	23	8.47
Schuster et al., 2012a	-0.14	0.56	0.31	-1.32, 0.95	13	14	6.90
Bovend’Eerdt et al., 2010	-0.33	0.50	0.25	-1.35, 0.70	15	15	7.25
Overall Effect	**0.48**	**0.22**	**0.05**	**0.04, 0.91**	**214**	**195**	**100**



Heterogeneity: χ^2= 39.36, df= 12 (p= .00), I^2= 69.51%; Overall effect: Z= 2.17 (p= .03)

Figure 3.1. Meta-analysis of the overall effect of imagery on movement.

Table 3.2

Imagery Meta-analysis Participant Information

Study	Average age of participants (years)	Time since stroke (months)	Location of stroke (left/right hemisphere)	Gender (males/ females)	Total number of participants
Verma et al., 2011	54.2 (7.6)	1.5 (0.8)	15/15	22/8	30
Santos-Couto-Paz et al., 2013	42.2 (12.2)	13 (6.5)	5/4	3/6	9
Liu et al., 2004a	71.9 (7.7)	0.5 (0.3)	No Data	22/24	46
Page et al., 2001a	64.6 (8.4)	6.5 (3.3)	4/9	10/3	13
Page et al., 2007	59.5 (13.5)	42 (13.1)	19/13	18/14	32
Lee et al., 2011	61.3 (9.4)	> 6	No Data	10/14	24
Hwang et al., 2010	47.2 (6.3)	23.6 (11.8)	15/9	18/6	24
Dijkerman et al., 2004	64 (9.0)	24 (0.8)	11/9	14/6	20
Schuster et al., 2012b	62.1 (9.9)	47 (45)	13/13	17/9	26
Ietswaart et al., 2011	67.4 (17.3)	2.8 (2.0)	43/40	70/51	121
Dickstein et al., 2013	72 (6.9)	11 (11.5)	10/13	16/7	23
Schuster et al., 2012a	65.1 (8.5)	38 (34.8)	15/12	20/7	27
Bovend’Eerdt et al., 2010	50.3 (14.1)	4.7 (4.1)	No Data	19/11	30

3.3.3. Study details. A total of 425 (male= 259; female= 166) stroke affected individuals participated in the 13 studies included in the meta-analysis. The mean age of participants for all studies was 60.1 years old (± 9.2) with an average time post-stroke of 18.4 months (± 16.7); see Table 3.2. Unfortunately, authors did not provide information regarding the area of cerebral circulation affected according to the Oxford Community Stroke Project (OCSP) Classification (Mead, Lewis, Wardlaw, Dennis, & Warlow, 2000). Also not included in studies was information regarding participants' severity of stroke. Authors did mainly report whether participants had experienced a stroke in the left or right hemisphere of the brain. Out of the 10 studies that provided information regarding stroke location, 150 patients experienced a stroke in the left hemisphere and 137 in the right. The mean duration of imagery therapy was four weeks (± 1.6) with the imagery sessions lasting on average 33 minutes (± 18.2) four times a week (± 1.9); see Table 3.2.

A variety of study designs have been used with activities imaged, including: ADL (Page et al., 2007; Santos-Couto-Paz et al., 2013), gait movements (Verma et al., 2011; Lee et al., 2011; Hwang et al., 2010; Dickstein et al., 2013;), reaching activities (e.g., reaching for a cup; Page et al., 2001a; Santos-Couto-Paz et al., 2013), picking up and moving blocks (Dijkerman et al., 2004) and imaging stages of and then the whole task (Schuster et al., 2012a). Imagery training also sometimes included mirror box, action observation (Ietswaart et al., 2011) and performance evaluation (Liu et al., 2004a; Hwang et al., 2010). Information regarding the study designs can be found in Table 3.4.

Table 3.3

Imagery Meta-analysis Imagery Duration and Intensity

Study	Duration of intervention (weeks)	Duration of imagery (minutes)	Frequency of imagery (Times a week)	Total amount of imagery per intervention (minutes)
Verma et al., 2011	2	15 minutes imagery, 25 minutes circuit training	7	210
Santos-Couto-Paz et al., 2013	4	30	3	360
Liu et al., 2004a	3	60	5	900
Page et al., 2001a	6	10 minutes imagery, 60 minutes physical therapy	5	300
Page et al., 2007	6	30	2	360
Lee et al., 2011	6	60	3	1080
Hwang et al., 2010	4	25-30	5	500-600
Dijkerman et al., 2004	4	Unknown	7	Unknown
Schuster et al., 2012b	2	50	3	300
Ietswaart et al., 2011	4	30-45	5	600-900
Dickstein et al., 2013	3	12	1	36
Schuster et al., 2012a	2	50	3	300
Bovend'Eerdt et al., 2010	6	15-20mins for each video clip Total time 30-40mins	Weeks 1-4 3 times Weeks 5-6 2 times	240-320

Table 3.4

Imagery Meta-analysis Study Designs

Study	Dependant variables	Type of imagery	Physical task(s) used	Control task(s)
Verma et al., 2011	Rivermead Visual Gait Assessment (RVGA), step length asymmetry, walking speed, 6min walk test and cadence	Imagery of real life walking situations followed by task-orientated circuit class training.	Walking related tasks	Lower extremity rehabilitation based on Bobath's neurodevelopmental technique.
Santos-Couto-Paz et al., 2013	Gait speed, Quality of movement, Amount of use, Minnesota manual dexterity test	Prior to imaging participants physically performed ADL tasks (e.g., grasping and gripping) in a quiet room and identified their movement errors. Tasks were then imaged and described 10 times. The whole process was repeated again.	Reaching and grasping	30mins Physical therapy consisting of mild stretching, strengthening exercises and muscular relaxation.
Liu et al., 2004a	Task performance week three	Task analysis, problem solving, practicing the tasks mentally.	ADL	Functional Training on relearning ADL
Page et al., 2001a	ARAT FMA	Tape recording of relaxation then imagery of the affected arm e.g. reach for a cup.	Balance walking training, gross arm movements and ADL.	Exposure to stroke information
Page et al., 2007	ARAT FMA for upper extremities	Mental practice of ADL plus physical practice of ADL.	ADL	Relaxation techniques and physical practice
Lee et al., 2011	Walking speed, cadence; for paretic and nonparetic side step length, stride length, single limb support, double limb support	30min imagery of normal gait movement and 30min treadmill training. First 15mins of imagery included watching a video of an explanation of normal gait movement.	Walking	30min treadmill gait training

Table 3.4 Continued

Study	Dependant variables	Type of imagery	Physical task(s) used	Control task(s)
Hwang et al., 2010	Walking velocity, Walking symmetry, DGI, TUG	Video locomotor imagery training with physical therapy.	Walking	Watched TV documentary with physical therapy.
Dijkerman et al., 2004	Barthel index	Picking up and moving 10 blocks three times.	Picking up and moving blocks.	No imagery
Schuster et al., 2012b	Berg Balance Scale	30min physical therapy followed by 20mins imagery including relaxation, a description of each motor task stage then refocusing into the room.	Lying, sitting, standing and walking	30mins physiotherapy and then listened to a 17min tape including relaxation, information about stroke then refocusing into the room.
Ietswaart et al., 2011	ARAT, Grip strength, Grip function, Barthel index	Imagery, mirror box and action observation.	ADL	Attention-Placebo control (visual imagery of objects) and Normal Care.
Dickstein et al., 2013	10m walk test, Community ambulation	Imagery started with 3 min relaxation, 9mins imaging three different environments including community interior (a mall), community exterior (street) and the participants home (3mins each).	Reaching exercises	Physical therapy of transport-reach exercises (spoon to mouth), bimanual exercises (folding clothes) and unimanual exercises (placing items in a jar).
Schuster et al., 2012a	Berg Balance Scale	Imagery of stages of motor tasks 5 times then performed once. The whole task then imaged four times lying down and four times standing next to a wall.	Lying, sitting, standing and walking	30mins physiotherapy and then listened to a 17min tape including relaxation, information about stroke then refocusing into the room.
Bovend'Eerdt et al., 2010	GAS, Barthel Index, RMI, TUG, ARAT, NEADLS	Watched two video clips including information about imagery and imagery strategies (still pictures).	ADL	Watched two video clips including general information about rehabilitation and motor learning (still pictures)

Note. GAS = Goal Attainment Scaling; RMI = Rivermead Mobility Index; TUG = Timed Up and Go; ARAT = Action Research Arm Test; NEADLS = Nottingham Extended ADL Scale; DGI = Dynamic Gait Index; FMA = Fugl-Meyer Assessment; ADL = Activities of Daily Living; OT = Occupational Therapy.

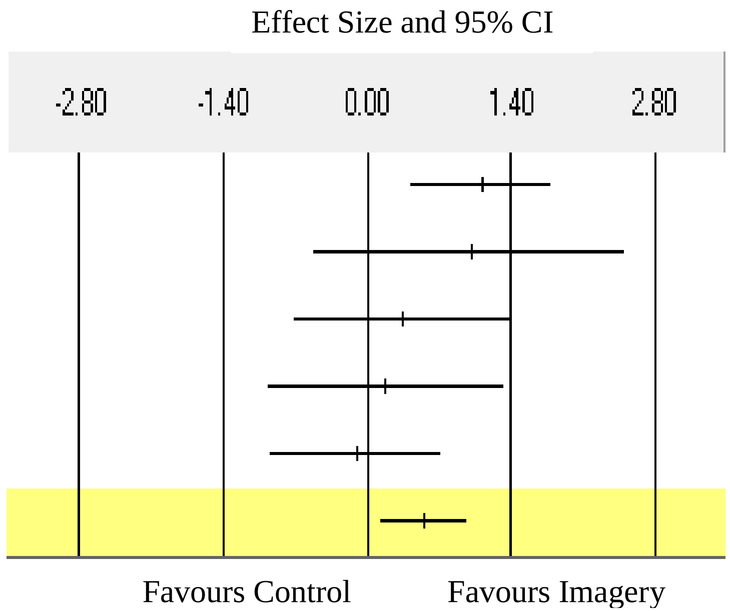
The imagery perspectives used during interventions and when imagery was performed also varied; see Table 3.5. Two meta-analyses investigated the effect of imagery perspective on physical movement. The results showed that a third person visual perspective produced a moderate mean treatment effect (*p*= .01; *d*= 0.56; 95% CI: 0.14 to 0.98; see Figure 3.2) while a first person visual perspective produced a small mean treatment effect (*p*= .10; *d*= 0.32; 95% CI: -0.06 to 0.70; see Figure 3.3). Four meta-analyses investigated whether imagery performed before, during, after or without physical practice effected physical movement. The results showed that when imagery was performed before physical practice a large mean treatment effect was produced (*p*= .06; *d*= 1.03; 95% CI: -0.03 to 2.09; see Figure 3.4). When imagery was performed during physical practice a small mean treatment effect was produced (*p*= .58; *d*= 0.29; 95% CI: -0.71 to 1.28; see Figure 3.5). However, a moderate mean treatment effect occurred when imagery was performed straight after physical practice (*p*= .01; *d*= 0.68; 95% CI: 0.19 to 1.17; see Figure 3.6). Finally, no effect was produced when imagery was performed without physical practice (*p*= .97; *d*= -0.01; 95% CI: -0.48 to 0.46; see Figure 3.7). The meta-analysis results on the effect of imagery perspective on physical movement and when imagery was performed do however need to be regarded with caution, as small study numbers were included in the analysis.

Table 3.5

Imagery Perspective and when Imagery was performed

Study	Imagery perspective	When imagery was performed
Verma et al., 2011	Unknown	Imagery before physical practice
Santos-Couto-Paz et al., 2013	First person	Straight after physical practice
Liu et al., 2004a	Third person	With physical practice
Page et al., 2001a	Third person	Straight after physical practice
Page et al., 2007	First person	Straight after physical practice
Lee et al., 2011	Third person	Imagery before physical practice
Hwang et al., 2010	Third person	No physical practice
Dijkerman et al., 2004	First person	Straight after physical practice
Schuster et al., 2012b	First person	Straight after physical practice
Ietswaart et al., 2011	First person	No physical practice
Dickstein et al., 2013	Third person	No physical practice
Schuster et al., 2012a	First person	With physical practice
Bovend’Eerdt et al., 2010	Unknown	With physical practice

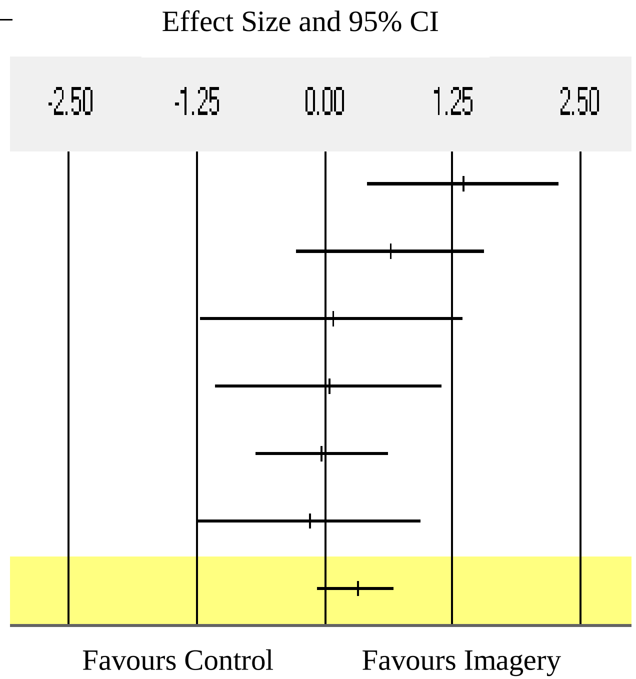
Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Liu et al., 2004a	1.13	0.35	0.12	0.45, 1.80	26	20	37.97
Page et al., 2001a	1.01	0.78	0.61	-0.51, 2.54	8	5	7.59
Lee et al., 2011	0.36	0.54	0.29	-0.69, 1.41	13	11	15.71
Hwang et al., 2010	0.18	0.59	0.34	-0.96, 1.32	13	11	13.40
Dickstein et al., 2013	-0.10	0.42	0.18	-0.92, 0.73	23	23	25.33
Overall Effect	**0.56**	**0.21**	**0.05**	**0.14, 0.98**	**83**	**70**	**100**



Heterogeneity: χ^2= 5.90, df= 4 (p= .21), I^2= 32.22%; Overall effect: Z= 2.62 (p= .01); Publication bias= 11; Model used= Fixed-effect

Figure 3.2. Meta-analysis of the effect of imagery from a third person perspective on movement.

Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Santos-Couto-Paz et al., 2013	1.37	0.48	0.23	0.42, 2.31	9	9	16.31
Page et al., 2007	0.65	0.48	0.22	-0.27, 1.58	16	16	17.05
Dijkerman et al., 2004	0.08	0.66	0.43	-1.20, 1.36	10	10	8.72
Schuster et al., 2012b	0.04	0.56	0.32	-1.06, 1.14	12	14	11.72
Ietswaart et al., 2011	-0.02	0.32	0.11	-0.65, 0.62	41	32	34.10
Schuster et al., 2012a	-0.14	0.56	0.31	-1.32, 0.95	13	14	12.10
Overall Effect	**0.32**	**0.19**	**0.04**	**-0.06, 0.70**	**101**	**95**	**100**

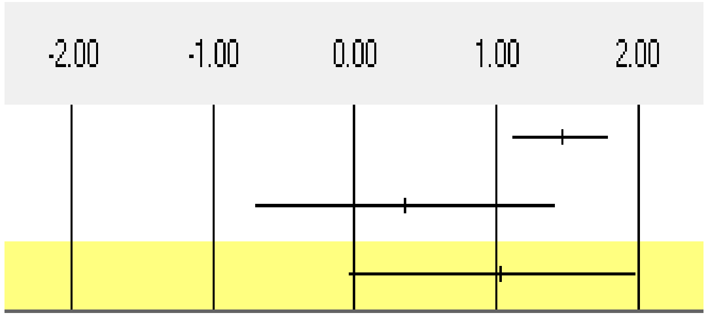


Heterogeneity: χ^2= 7.40, df= 5 (*p*= .19), I^2= 32.39%; Overall effect: *Z*= 1.67 (*p*= .10); Publication bias=6; Model used= Fixed-effect

Figure 3.3. Meta-analysis of the effect of imagery from a first person perspective on movement.

Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Verma et al., 2011	1.46	0.18	0.03	1.11, 1.81	15	15	60.63
Lee et al., 2011	0.36	0.54	0.29	-0.69, 1.41	13	11	39.37
Overall Effect	**1.03**	**0.54**	**0.29**	**-0.03, 2.09**	**28**	**26**	**100**

Effect Size and 95% CI

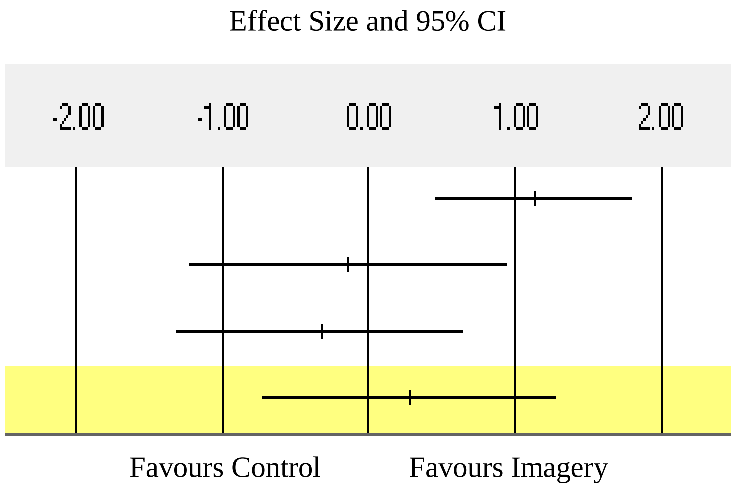


Favours Control Favours Imagery

Heterogeneity: χ^2=3.82, df= 1 (*p*= .05), I^2= 73.84%; Overall effect: *Z*= 1.90 (*p*= .06); Publication bias= 6; Model used= Random-effect

Figure 3.4. Meta-Analysis of the effect of imagery when performed before physical practice on movement.

Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Liu et al., 2004a	1.13	0.35	0.12	0.45, 1.81	26	20	38.48
Schuster et al., 2012a	-0.14	0.56	0.31	-1.23, 0.95	13	14	30.03
Bovend'Eerdt et al., 2010	-0.33	0.50	0.25	-1.31, 0.65	15	15	31.49
Overall Effect	**0.28**	**0.51**	**0.26**	**-0.72, 1.29**	**54**	**49**	**100**

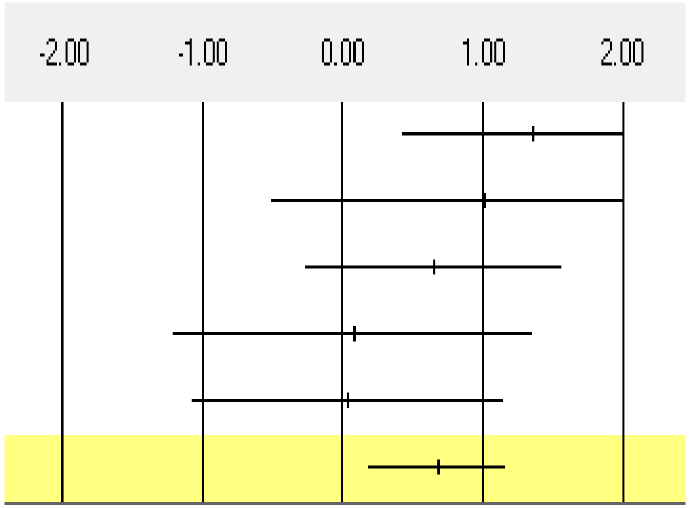


Heterogeneity: χ^2=7.38, df= 2 (p= .03), I^2= 72.91%; Overall effect: Z= 0.55 (p= .58); Publication bias= 2; Model used= Random-effect

Figure 3.5. Meta-Analysis of the effect of imagery when performed during physical practice on movement.

Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Santos-Couto-Paz et al., 2013	1.37	0.48	0.23	0.42, 2.31	9	9	27.16
Page et al., 2001a	1.01	0.78	0.61	-0.51, 2.54	8	5	10.41
Page et al., 2007	0.65	0.47	0.22	-0.27, 1.58	16	16	28.39
Dijkerman et al., 2004	0.08	0.66	0.43	-1.20, 1.36	10	10	14.53
Schuster et al., 2012b	0.04	0.57	0.32	-1.06, 1.14	12	14	19.51
Overall Effect	**0.68**	**0.25**	**0.06**	**0.19, 1.17**	**55**	**54**	**100**

Effect Size and 95% CI



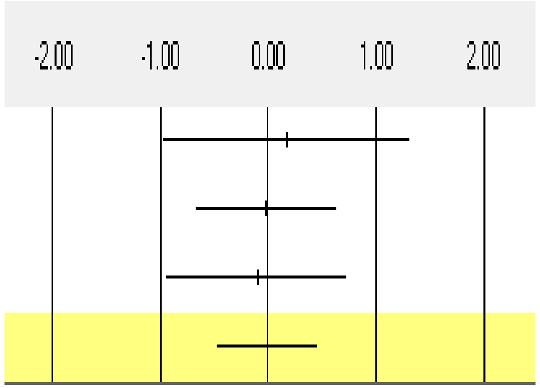
Favours Control Favours Imagery

Heterogeneity: χ^2=4.34, df= 4 (*p*= .36), I^2= 7.90%; Overall effect: *Z*= 2.72 (*p*= .01); Publication Bias= 14; Model used= Fixed-effect

Figure 3.6. Meta-Analysis of the effect of imagery when performed after physical practice on movement.

Study	Effect Size	Standard Error	Variance	95% CI	Sample Size Imagery	Sample Size Control	Weight (%)
Hwang et al., 2010	0.18	0.59	0.34	-0.96, 1.32	13	11	16.72
Ietswaart et al., 2011	-0.02	0.32	0.11	-0.65, 0.62	41	32	51.69
Dickstein et al., 2013	-0.10	0.42	0.18	-0.92, 0.73	23	23	31.59
Overall Effect	**-0.01**	**0.24**	**0.06**	**-0.46, 0.05**	**77**	**66**	**100**

Effect Size and 95% CI



Favours Control Favours Imagery

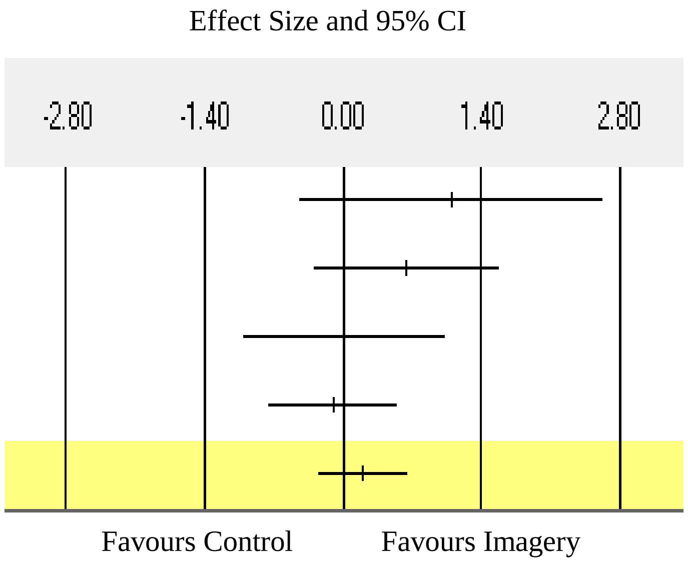
Heterogeneity: χ^2=0.15, df= 2 (*p*= .93), I^2= 0.00%; Overall effect: *Z*= -0.05 (*p*= .96); Publication bias= 3; Model used= Fixed-effect

Figure 3.7. Meta-Analysis of the effect of imagery when performed without physical practice on movement.

In contrast to the varying study designs used, the participant inclusion criteria were similar for all studies except time post-stroke, which varied from one month to three years. The participant inclusion criteria often included no aphasia, severe cognitive neglect, severe spasticity or any problem that would affect task performance, such as a hip replacement (see Appendix F). Imagery ability were often measured with the MIQ-RS, with participants needing to score ≥25 (Verma et al., 2011; Page et al., 2001a) or >32 (Hwang et al., 2010) to be included in the study. Similar participant criteria have been identified in previous literature reviews by Braun et al. (2006) and Barreca et al. (2003).

3.3.4. The effect of imagery on arm-function, activities of daily living and gait. Numerous dependant variables were used to determine improvements in movement following imagery interventions. Four meta-analyses were conducted focusing on studies that used the ARAT, ADL, Barthel Index and gait analysis. The results showed that a small mean treatment effect was produced when arm function was measured with the ARAT (*p*= .37; *d*= 0.21; 95% CI: -0.25 to 0.66; see Figure 3.8). There were conflicting results when ADL functioning was analysed. No treatment effect was found when the Barthel index was used (*p*= .62; *d*= 0.12; 95% CI: -0.37 to 0.61; see Figure 3.9), but ADL produced a moderate effect (*p*= .11; *d*= 0.48; 95% CI: 0.04 to 0.91; see Figure 3.10). However, even though the heterogeneity testing reported that the ADL meta-analysis data was homogenous the forest plot (see Figure 3.10) and large confidence intervals indicated otherwise. Therefore, the ADL meta-analysis was re-analysed without the findings of the Liu et al. (2004) study, as it was suspected to be an outlier. The new analysis found that imagery had no effect on improving ADL performance and that the Liu et al. (2004) study was indeed an outlier (*p*= .91; *d*= -0.03; 95% CI: -0.05 to 0.4; see Figure 3.11). Finally, a small to moderate mean treatment effect was produced when walking was measured, with gait analyses variables, such as gait speed and stride length (*p*= .58; *d*= 0.31; 95% CI: -0.79 to 1.41; see Figure 3.12). The meta-analysis results on the effect of imagery on arm-function, ADL and gait do need to be considered with caution, as small study numbers were included in the analysis.

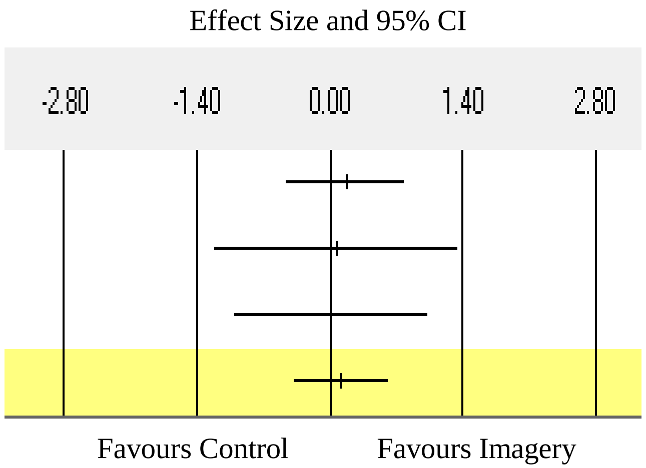
Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Page et al., 2001a	1.11	0.78	0.61	-0.42, 2.64	8	5	8.73
Page et al., 2007	0.65	0.48	0.23	-0.29, 1.59	16	16	23.15
Bovend'Eerdt et al., 2010	0.01	0.52	0.27	-1.01, 1.03	15	15	19.72
Ietswaart et al., 2011	-0.09	0.33	0.11	-0.74, 0.56	41	32	48.40
Overall Effect	**0.21**	**0.23**	**0.05**	**-0.25, 0.66**	**80**	**68**	**100**



Heterogeneity: χ^2=3.14, df= 3 (*p*= .37), I^2= 4.33%; Overall effect: *Z*= 0.89 (*p*= .37); Publication bias= 1; Model used= Fixed-effect

Figure 3.8. Meta-Analysis of the effect of imagery on arm-function (ARAT).

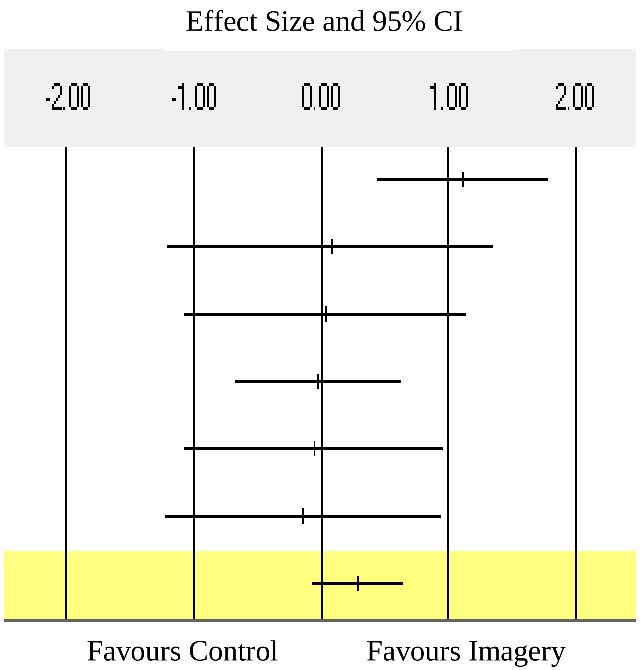
Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Ietswaart et al., 2011	0.17	0.32	0.10	-0.45, 0.79	41	32	62.39
Dijkerman et al., 2004	0.08	0.66	0.43	-1.21, 1.37	10	10	14.51
Bovend'Eerdt et al., 2010	0.02	0.52	0.27	-1.00, 1.04	15	15	23.11
Overall Effect	**0.12**	**0.25**	**0.06**	**-0.37, 0.61**	**66**	**57**	**100**



Heterogeneity: χ^2=0.07, df= 2 (*p*= .97), I^2= 0.00%; Overall effect: *Z*= 0.49 (*p*= .62); Publication bias= 0; Model used= Fixed-effect

Figure 3.9. Meta-Analysis of the effect of imagery on Barthel Index.

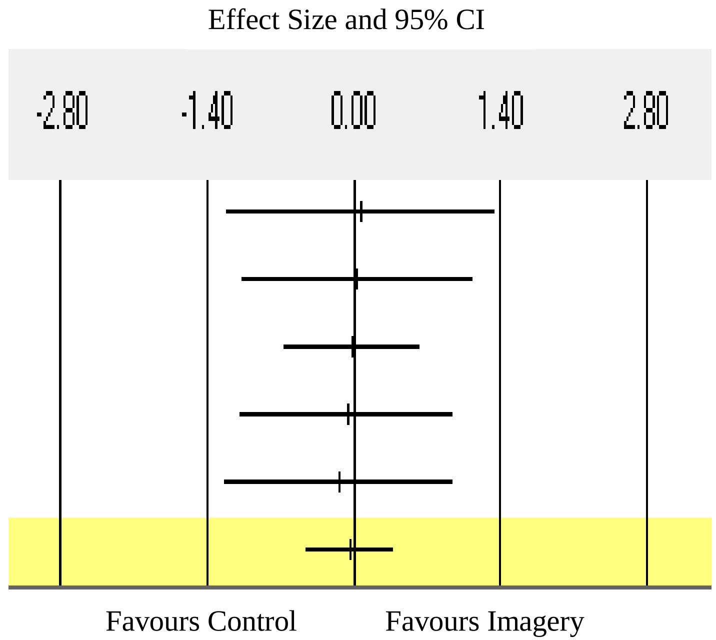
Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Liu et al., 2004	1.12	0.35	0.12	0.44, 1.80	26	20	27.96
Dijkerman et al., 2004	0.08	0.66	0.43	-1.21, 1.37	10	10	7.80
Schuster et al., 2012b	0.04	0.57	0.32	-1.07, 1.15	12	14	10.49
Ietswaart et al., 2011	-0.02	0.33	0.11	-0.67, 0.63	41	32	30.50
Bovend'Eerdt et al., 2010	-0.06	0.52	0.27	-1.08, 0.96	15	15	12.43
Schuster et al., 2012a	-0.14	0.56	0.31	-1.23, 0.95	13	14	10.82
Overall Effect	**0.48**	**0.22**	**0.05**	**0.04, 0.91**	**117**	**105**	**100**



Heterogeneity: χ^2= 7.96, df= 5 (*p*= .16), I^2= 37.20%; Overall effect: *Z*= 1.61 (*p*= .11); Publication bias= 11; Model used= Fixed-effect

Figure 3.10. Meta-Analysis of the effect of imagery on ADL.

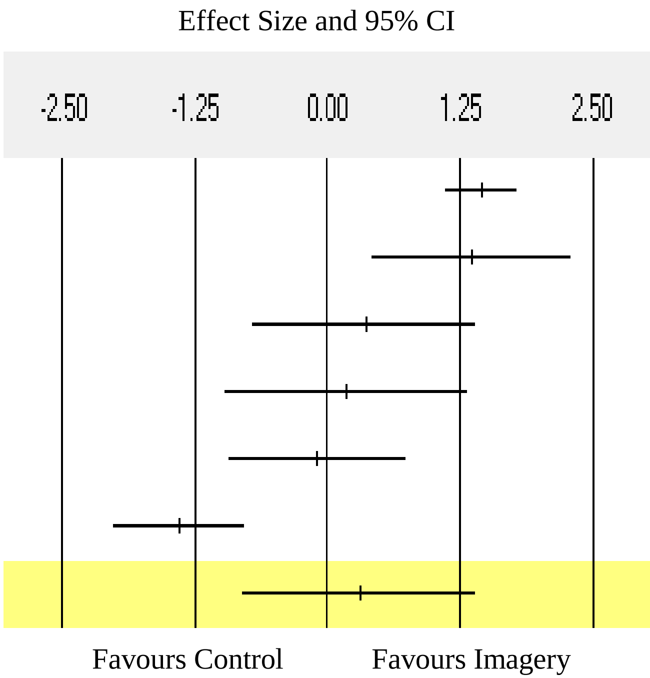
Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Dijkerman et al., 2004	0.08	0.66	0.43	-1.21, 1.37	10	10	10.83
Schuster et al., 2012b	0.04	0.57	0.32	-1.07, 1.15	12	14	14.55
Ietswaart et al., 2011	-0.02	0.33	0.11	-0.67, 0.63	41	32	42.34
Bovend'Eerdt et al., 2010	-0.06	0.52	0.27	-1.08, 0.96	15	15	17.25
Schuster et al., 2012a	-0.14	0.56	0.31	-1.23, 0.95	13	14	15.03
Overall Effect	**-0.03**	**0.22**	**0.05**	**-0.45, 0.4**	**91**	**85**	**100**



Heterogeneity: χ^2= 0.09, df= 4 (p= .99), I^2= 0.00%; Overall effect: Z= -0.12 (p= .91); Publication bias= 6; Model used= Fixed-effect

Figure 3.11. Meta-Analysis of the effect of imagery on ADL without Liu et al. (2004) study.

Study	Effect Size	Standard Error	Variance	95% CI	Sample Size: Imagery	Sample Size: Control	Weight (%)
Verma et al., 2011	1.46	0.17	0.03	1.12, 1.80	15	15	18.19
Santos-Couto-Paz et al., 2013	1.37	0.48	0.23	0.43, 2.31	9	9	16.31
Lee et al., 2011	0.36	0.54	0.29	-0.69, 1.41	13	11	15.82
Hwang et al., 2010	0.18	0.58	0.34	-0.96, 1.32	13	11	15.44
Dickstein et al., 2013	-0.10	0.42	0.18	-0.92, 0.73	23	23	16.75
Bovend'Eerdt et al., 2010	-1.40	0.31	0.1	-2.02, 0.78	15	15	17.49
Overall Effect	**0.31**	**0.56**	**0.32**	**-0.79, 1.41**	**88**	**84**	**100**



Heterogeneity: χ^2= 70.14, df= 5 (p= .00), I^2= 92.87%; Overall effect: Z= 0.56 (p= .58); Publication bias= 5; Model used= Random-effect

Figure 3.12. Meta-Analysis of the effect of imagery on gait.

3.3.5. Comparisons between studies included in the meta-analysis. Some of the selected studies provided limited information regarding the specifics of the imagery interventions. For example, rarely were details provided regarding visual perspective and experimenter instructions. This has resulted in comparisons in methods between studies being difficult, and the repeatability of these studies being very low. The five studies with between-participant treatment estimates > .50 used both first and third person visual imagery of ADL (Page et al., 2001a; 2007), task analysis through video and picture cards (Liu et al., 2004a), verbally describing the tasks being performed (Santos-Couto-Paz et al., 2013) and imagery of reaching, grasping (Page et al 2001a) and walking (Verma et al., 2011). The study by Verma et al. (2011) scored the highest between-participant treatment estimate (*d*= 1.46) and included circuit training instead of physiotherapy, which is regularly included. Studies with between-participant treatment estimates < .50 included imagery of gait training (Lee et al., 2011; Hwang et al., 2010; Dickstein et al., 2013), moving tokens with the affected arm (Dijkerman et al., 2004) and imagery, mirror box and action observation of ADL (Ietswaart et al., 2011). The additional meta-analyses conducted to assess the effect of imagery perspective, when imagery was performed and different dependant variables used to assess movement found interesting results. Imagery of ADL from a third person perspective and performed straight after physical practice improved ADL performance.

3.3.6. Results of the studies that could not be included in the meta-analysis because they had incomplete data or high variance. Eight studies passed the quality assessment, but were not included in the meta-analysis because of incomplete data (Liu et al., 2009; Malouin et al., 2009; Müller et al., 2007; Riccio et al., 2010) or high variance (Cho et al., 2013; Hosseini et al., 2012; Page 2000; Page et al., 2005). The eight studies varied in study designs and dependant variable, which is similar to the findings of the meta-analyses. Imagery of the affected arm when performing weight bearing and functional tasks significantly improved arm function (Page, 2000). Imagery of ADL increased the amount of affected limb use and movement quality (Page et al., 2005). Imagery of ADL, by individuals seven days post-stroke, also significantly improved the performance of untrained tasks, when assessed on a 7 point Likert scale (Liu et al., 2009). Imagery has been found by Cho et al. (2013), Hosseini et al. (2012) and Malouin et al. (2009) to facilitate the relearning of gait and balance control. Imagery has been found to have a similar effect on increasing pinch grip as repetitive execution in individuals' one-month post stroke (Müller et al., 2007). In contrast, Riccio et al. (2010) found minimal improvements in arm function when imagery was performed after physical practice when lying down in a quiet room. Several imagery interventions also required participants to participate in relaxation therapy for a few minutes prior to imagery (Hosseini et al., 2012; Page, 2000; Page et al., 2005; Riccio et al., 2010).

3.4. Discussion

The aim of this study was to quantify the effects of imagery on upper- and lower-limb movement ability post-stroke, through the use of meta-analytic techniques. The aim of the study was fulfilled as thirteen studies were included in the meta-analysis. The resultant pooled between study estimates resulted in a heterogeneous sample and a moderate mean treatment effect of 0.48 was produced. This treatment effect was lower than that of 0.84 reported by Langhorne et al. (2009). However, the meta-analysis by Langhorne et al. (2009) only included four imagery studies as the study inclusion criteria stated that only systematic reviews from the Cochrane Library would be included in the analysis. There was also no information in the meta-analysis by Langhorne et al. (2009) regarding which systematic reviews were selected from the Cochrane Library and in which systematic reviews the four selected studies were found. It is also unknown what the inclusion criteria were in these reviews. Therefore, the range of studies represented by Langhorne et al.'s findings was very limited, and did not represent the whole of the stroke imagery literature that focuses on improvements in movement. However, the current study provides a more comprehensive picture as to the effectiveness of imagery in stroke studies to date.

Two more resent meta-analysis have been conducted by Braun et al., 2013 and Kho et al., 2013. The meta-analysis by Kho et al. (2013) included a small number of studies (5 RCTs). They found that studies that measured movement improvements with the upper-extremity section of the FMA found no significant difference between the imagery and control group. A significant difference was found when movement ability was measured with the ARAT. Even though Kho et al. (2013) performed a meta-analysis they did not report any effect sizes for individual studies, comparisons between dependant measures or an overall treatment effect. Participant criteria were also not statistically compared by Kho et al. (2013) or Braun et al. (2013), only a descriptive interpretation was provided.

A more comprehensive meta-analysis than Langhorne et al. (2009) and Kho et al. (2013), on the use of imagery during stroke rehabilitation, was been conducted by Braun et al. (2013). Fourteen RCTs were included in the meta-analysis by Braun et al. (2013). When the ARAT was used to measure movement improvement, imagery was found to produce a moderate to large effect (0.62) and a large effect was found when change in activity performance was measured (0.9). However, imagery did not significantly improve ADLs, Barthel index or Rivermead mobility index. Unfortunately, Braun et al. (2013) did not report the mean treatment effect of imagery so a direct comparison cannot be made with the results of the meta-analysis performed in study one. However, the results of both meta-analyses seem to be similar. Both meta-analyses found that studies that measure the effect of imagery with ARAT and performance improvement, find imagery to be more effective at improving movement post-stroke than the Barthel index and Rivermead mobility index.

The moderate mean treatment effect suggests that the benefit of imagery compared to no imagery control conditions is limited and in some instance no more effective, for example the study by Bovend'Eerdt et al (2010). However, the high standard deviation and confidence values reported in this meta-analysis reflect the fact that some studies have reported stronger effects. Interestingly, five studies (Liu et al., 2004a; Page et al. 2001a; Page et al., 2007; Santos-Couto-Paz et al., 2013; Verma et al, 2011) produced strong between-participant treatment estimates. All five studies that produced strong between-participant treatment estimates were randomised controlled trials and will be scrutinised to help identify potential explanations for these stronger imagery effects.

3.4.1. The effect of age of participants, time post-stroke, duration of therapy and duration and frequency of imagery on imagery effectiveness. The multiple linear regression revealed that age of participants, time post- stroke, duration of therapy and duration and frequency of imagery did not predict and did not explain the significant amount of the variance in the between-participant treatment estimate. Therefore, none of these variables can explain why the imagery interventions in these studies proved more effective than those of the other included studies. The meta-analysis has highlighted that high between-participant treatment estimates can occur in studies that have included patients that have sustained a stroke 42 months (Page et al., 2007) prior to participating in imagery therapy. A common clinical principle is that chronic stroke patients (>1 year post-stroke) cannot respond to motor rehabilitation strategies (Hewett et al., 2007). But the findings of the meta-analysis highlight that for some individuals affected by stroke, rehabilitation will be an on-going process to try to maintain and refine skills. This could involve working with specialists for months or years after experiencing a stroke (NINDS, 2008).

3.4.2. Imagery delivery. It is important to know what instructions experimenters gave individuals affected by stroke before and during imagery so that therapists can replicate the same instructions during therapy sessions. The results of the meta-analysis concurred with the observations in section 2.4.2 of the literature review. That is, a large proportion of experimenters did not report in detail the instructions that they gave participants. Liu et al. (2004a) did provide information regarding the sequence of the experimental protocol but there was no detailed information given regarding what participants were instructed to focus on (e.g., kinaesthesis and/or imagery vividness) when imaging their own performance. However, the study by Dunsky et al. (2008), which was excluded from the meta-analysis, does provide a detailed account of the imagery instructions. Participants were asked to close their eyes and to feel the movement of their body as they were walking and to see the greenery that was around them. Unfortunately, the imagery interventions that used an audio recording (e.g., Page et al., 2000) did not include a written script of what the recording said to participants; therefore, preventing the identification of key aspects of the imagery intervention that improve its effectiveness. However, the instructions given by experimenters regarding imagery perspective were reported by most researchers. Only Verma et al. (2011) and Boverd'Eerdt et al. (2010) did not state from which imagery perspective participants were asked to image.

The experimenters did include information regarding the duration and frequency of the imagery interventions. On average the imagery interventions were performed for four weeks ($\pm$ 1.6) with the imagery sessions lasting on average 33 minutes ($\pm$ 18.2) four times a week ($\pm$ 1.9). Participants may not have been asked to perform imagery every day to allow participants the time to receive other forms of stroke rehabilitation that are not related to improving movement, such as speech and language therapy. Individuals affected by stroke can become tired easily (Stroke Association, 2013). Therefore, performing imagery four days a week can allow participants to have ample rest. Therapists need to be careful that imagery interventions are not too long as patients might become tired.

3.4.2.1. When and where imagery interventions were performed. The timing of the imagery (i.e., when it was administered) differed between the studies. The imagery intervention administered during the study by Page et al. (2001a); Page et al. (2007); Dijkerman et al. (2004); Santos-Couto-Paz et al. (2013) and Schuster et al (2012b) was performed straight after physical therapy in a quiet room with the use of an audio tape. The performance of imagery immediately following physical practice may have been beneficial as the tasks performed during physical practice would have been fresh in the participants' minds. A moderate mean treatment effect of 0.68 was produced when imagery was performed after physical therapy. If the imagery was performed a long time after physical practice, it is possible that patients will have found it more difficult to recall the tasks and associated kinaesthesis. Therefore, finding therapy tasks difficult to image.

Imagery performed in a quiet room straight after physical therapy could prevent any distractions occurring during the imagery and enable the participants to feel relaxed. Reasons for adding relaxation at the beginning of imagery interventions was to heighten concentration and promote imagery vividness, performance and attention (Cupal & Brewer, 2001). By including relaxation at the beginning of an imagery intervention and refocusing into the room at the end, the time allotted to imagery can be as little as eight minutes of an 18-minute intervention (Nilsen, Gillen, DiRusso, & Gorden, 2012).

However, Holmes and Collins (2001) have advised that imagery interventions in sport should be conducted in a familiar environment and where the skill is normally performed, for example on the football pitch. Imagery performed on the training pitch with participants wearing their match kit has been found to improve hockey penalty flick performance more than traditional imagery (Smith et al., 2007). In sport, traditional imagery with a therapeutic relaxation focus has been performed in a relaxed environment far removed from actual sporting performance, in everyday clothing and without any sporting implements (e.g., hockey stick; Grouios, 1992). This was also the case with the traditional imagery group in this study.

Taking advice from the sporting literature and putting it into a medical context, imagery during stroke rehabilitation possibly should be performed where patients would normally perform the task, for example at home or in the treatment room during physical therapy. However, the results of the meta-analyses investigating when imagery is performed actually support the notion that imagery is more effective when performed before (1.03) and straight after physical practice (0.68). The results essentially therefore suggest that there is no benefit to doing imagery during physical therapy. However, it is unclear whether imagery performed prior to and straight after physical therapy was effective because of when it was carried out or the environment it was performed in. Therefore, more research is needed to determine whether the environment that imagery is performed in, during stroke rehabilitation, contributes to its effectiveness.

The imagery interventions were also performed during physical practice (Bovend'Eerdt et al., 2010; Liu et al., 2004a; Schuster et al., 2012a) and produced a small mean treatment effect of 0.28. The study results varied greatly with Liu et al. (2004) producing a large effect size of 1.13, while the other studies had minus results. There are potential benefits to performing imagery during physical practice. Performing imagery during physical practice could be beneficial to motor learning and facilitate the retention of tasks, as found in the sporting literature (Lee & Genovese, 1989; Kohl, Ellis, & Roenker, 1992). In the stroke population imagery performed during physical practice reactivates recently used motor representations, leading to an increased effectiveness of physical practice (Ietswaart et al., 2011). Therapists should therefore, integrate imagery into physical practice sessions and not perform imagery in isolation.

When imagery is performed during physical therapy action observation of the physical task also occurs, as patients observe the therapists demonstrating the physical tasks. As previously mentioned in section 2.12, observation of movements with the intent to imitate (Pomeroy et al., 2005) can increase cortical excitability (Gangitano et al., 2001) and involve cognitive processes associated with motor learning (Stefan et al., 2005). Action observation could also provide participants with important information regarding the form and identifying the sequencing of a movement. This could enable both accurate and detailed images, which include visual and kinaesthetic information, of the phases of a task. Including imagery during physical practice would also help prevent participants from becoming fatigued as fewer physical repetitions are performed.

The effect of imagery on physical performance has also been investigated without physical practice (Hwang et al., 2010; Ietswaart 2011; Dickstein et al., 2013). Imagery was found to have no treatment effect when performed without physical therapy (effect size -0.01). It may be that the lack of physical therapy reduces imagery vividness. This could be because the ability to generate images during imagery has been found to decline with age, regardless of health status (Mulder, Hochstenbach, van Heuvetan, & den Olter, 2007). These researchers also found a weak but significant shift from a first person visual perspective to a third person visual perspective with increasing age. This has also been found to occur when imaging post-stroke (Ewan et al., 2010b). It has been hypothesised that these changes occur because of decreases in physical activity that often occur during aging and post-stroke (Mulder et al., 2007). Inactivity affects individuals' physical ability to perform tasks as well as their ability to image the task. Changes in imagery perspective following stroke need to be considered as imagery from a first person visual perspective has been shown to be more effective when learning and re-learning skills (Jackson et al., 2001). However, imagery from a third person visual perspective helps enhance the form of a movement (Fery, 2003). Therefore, imagery does seem to be more beneficial in improving movement when combined with physical therapy (Liu et al., 2004a) than being performed in isolation (Hwang et al., 2010).

3.4.3. Imagery Content. The content of imagery is as important as the timing of the intervention and where it is performed (Braun et al., 2006). All five studies that produced strong between-participant treatment estimates involved imaging ADL such as reaching, grasping and hand dexterity in both affected and un-affected limbs. The imagery interventions only focused on upper-limb movement tasks.

3.4.3.1. Imagery perspective. An important aspect of imagery content is visual perspective. In the sport psychology literature the visual perspective employed (first or third person) has been identified as a key influence on the effectiveness of imagery (McCarthy, Wilson, Keegan, & Smith, 2012). In the examined studies that specified which perspective were used, both first person (Page et al., 2005; 2007) and third person imagery (Page, 2000; Page et al., 2001a) significantly improved motor performance. However, the results of the two meta-analyses that investigated imagery perspective found that a third person visual perspective (0.56) is probably more beneficial at improving movement ability following a stroke than a first person visual perspective (0.32). This is perhaps not surprising as a third person visual perspective helps enhance the form of a movement (Fery, 2003) which is an important aspect when relearning skills. The inclusion of kinesthesis could also be a key factor to motor function improvement through imagery post-stroke. Experiencing kinesthesis during imagery could enable individuals with hemiparesis to become aware of the position of the affected limb, allow active or passive limb movement to be perceived and its direction, improving coordination, strengthen neural networks and the priming of motor neurons (Mulder, 2007). Therefore, regardless of which imagery perspective is being used patients should attempt to experience kinesthesis during imagery.

3.4.3.2. Optimising imagery effectiveness. A notable feature of the study by Liu et al. (2004a), was the inclusion of task sequencing analysis. The task sequencing analysis occurred during week one of Liu et al.'s (2004a) three week imagery intervention. Task sequencing analysis was performed to facilitate motor planning and problem identification with the aid of computer generated pictures and movies. By combining computer generated pictures and movies with imagery participants also performed action observation. Action observation may have aided in image generation by providing more detail on the form of the movement to be imaged. It is likely that neural stimulation would have occurred during both imagery and action observation, as it has been reported by Filimon et al. (2007) that both imagery and action observation share similar neural substrates with action execution.

The therapists in the study by Liu et al. (2004a) also informed patients how to rectify their own movement problems, therefore enabling the imagery to be personalised to the patients' individual needs. Interestingly imagery that is personalised to the patients' individual needs has been shown to increase muscle activation in healthy individuals (Wilson et al., 2010), so may help activate the target muscle in stroke patients, though this requires further investigation. Research that compares imagery interventions that include task sequencing analysis to imagery interventions that do not include such analysis has currently not been performed. Future research in this area would be a useful addition to the imagery and stroke literature by helping to inform therapists' work in this area.

Several other imagery interventions did not solely involve imagery, but also included action observation through the use of video, flash cards (Bovend'Eerdt et al., 2010; Hwang et al., 2010) and mirror box therapy (Ietswaart et al., 2011). It is surprising that the study by Liu et al. (2004a) produced a high between-participant treatment estimate but the studies by Bovend'Eerdt et al. (2010) and Hwang et al. (2010), which also used action observation, produced small between-participant treatment estimates. This may be because the action observation was of still images and not personalised (Bovend'Eerdt et al., 2010; Hwang et al., 2010), unlike in research by Liu et al. (2004a). This suggests that when action observation and imagery are combined, action observation needs to be personalised and should include the observation of the entire movement.

It was also unexpected that when imagery was combined with action observation and mirror box during the study by Ietswaart et al. (2011) that a negative between-participant treatment effect of -0.02 was produced. During mirror box therapy, physical performance of the tasks occurs and the mirror provides personalised action observation of the participants' movements. The physical practice and personalisation should enable personalised image generation and increase participants' kinaesthetic awareness (Malouin & Richards, 2010; Malouin et al., 2004). Possible reasons for this surprising finding are explored in the following section.

The study by Ietswaart et al. (2011) included action observation and mirror box therapy as well as imagery but produced a negative between-participant treatment estimate. Ietswaart et al. (2011) suggested that their intervention was ineffective because it was not combined with physical practice. Therefore, the benefit of imagery that has previously been found by Page (2000) and others is essentially due to combining physical practice with imagery. However, imagery was also performed without physical practice in the study by Crajé et al. (2010), which found significant improvements in reaching and grasping with the affected hand, and a moderate between-participant treatment estimate of 0.54 was found during the meta-analysis, indicating that Ietswaart et al's (2011) conclusion in this regard could be questioned.

Ietswaart et al. (2011) did not attribute the use of sub-acute stroke participants to be the cause of the low treatment effect. This is because imagery has previously been found to improve ADL, on average 13.9 days post-stroke ($\pm$10; Liu et al., 2004a) in acute stroke patients. However, after the first few days following a stroke, many of the surviving brain tissues increase or reorganise their activity (Nishimura et al., 2007) through increased brain stimulation (Takatsuru et al., 2009) and axon sprouting (Ramirez, 2001). Therefore, as the brain is experiencing potentially large changes in neural structure shortly after stroke, it might be more beneficial to implement imagery when the brain is more stable.

The inclusion criteria used by Ietswaart et al. (2011) stated that participants had to score in-between 3-51 on the ARAT. Including a wide ARAT score range would have allowed patients with varying levels of movement ability to participate in the study. Participants' varying levels in movement ability could account for the large standard deviation values reported in the ARAT, grip strength, grip function and Barthel index scores. Large variations in results indicate that it is possible that some participants did improve in movement function following imagery. Since the participants' data were averaged, any inter-individual variations that might have occurred following the imagery intervention were unidentifiable.

Ietswaart et al. (2011) also suggested that although evidence of imagery improving movement ability has been reported during studies with a small sample size, we need to be aware of the role of publication bias. Studies that report negative findings, with an equally small sample size as published studies with positive findings, are potentially not being published. In the literature, studies with few participants have reported positive effects of imagery (e.g., Page et al., 2001a). In contrast large well-controlled studies, such as Ietswaart et al. (2011) have not found imagery to have a positive effect on movement. Therefore, the small studies find positive results, which may be unrepresentative when taking into consideration other well conducted studies such as Ietswaart et al. (2011). This asymmetric funnel has been recognised in clinical trials in the general literature (Egger et al., 1997). Therefore, more well controlled studies combining imagery, action observation and mirror box therapy need to be performed.

3.4.4. Effectiveness of imagery in improving lower-limb movement.

The study that produced the largest effect size was by Verma et al. (2011) and it included task-orientated circuit classes. The imagery and exercise classes focused on improving walking, but overall studies that focused on gait training produced a small-to-moderate treatment effect (d= 0.31). This is because there was a large variation in results with effect sizes ranging from 1.46 to -1.40 (Bovend'Eerdt et al., 2010). Imagery focusing on improving lower-limb function may have minimal effect because the muscles in the lower-limb are larger (Saladin, 2004). The larger lower-limb muscles require a greater amount of muscle activation to produce movement than upper-limb muscles (Kern et al., 2001). It has also been reported by Kern et al. (2001) that during daily activity, in healthy individuals, there is a greater amount of muscle activity between pairs of muscles in the lower-limb than in the upper-limb. The findings by

Kern et al. (2001) suggest that daily muscle activity in healthy individuals requires greater muscle coordination in the lower-limb than in the upper-limb, as greater muscle activation was recorded between pairs of muscles in the lower-limb.

The muscles in the lower-limb also require more strength than muscles in the upper-limb, as lower-limb muscle strength is necessary for weight-bearing and balance (Saladin, 2004). Therefore, task difficulty is higher for tasks performed with the lower-limb. Given this, lower-limb imagery interventions might need to last longer or be performed more frequently than upper-limb imagery interventions to enable improvements in movement to occur. More research is needed to try to improve the effectiveness of imagery on lower-limb performance. Interestingly, the UK's Intercollegiate Stroke Working Party (2012) recommended that imagery should only be used to improve arm function and not for lower-limb rehabilitation; the findings of the meta-analysis seem to support their judgement. The Intercollegiate Stroke Working Party (2012) did not give any reasons why imagery should only be performed with the upper-limb.

3.4.5. Dependent measures used. As well as imagery interventions including various techniques, the selected studies also used a variety of different dependent measures. The dependent measure that produced the highest between-participant treatment estimate was gait training (0.31). The additional meta-analyses looking at the use of dependant variables all produced small treatment effects. This could be because a small number of studies were included in each analysis with large variations in effect sizes. These results coincide with the results of the literature review conducted by Moulin et al. (2013). A limitation of studies that included biomechanical analysis of the lower-limb, is that changes in lower-limb joint angles were not measured throughout the entire walking cycle. Measuring joint angles throughout the entire movement cycle could help identify which part of the movement is detrimentally affecting performance. Additionally, further research is needed to investigate the effect of imagery on improving upper-limb movement patterns through the use of biomechanical movement analysis, as the studies reported in the meta-analysis have only used scales of movement.

3.4.6. Comparison of meta-analysis results to previous systematic reviews. The results of the meta-analysis do agree with previous systematic literature reviews regarding participant inclusion criteria, study design and the amount of detail included in the imagery content. As previously mentioned in the introduction section 2.7, nine systematic literature reviews have identified that studies investigating the use of imagery to improve movement vary in, study design and do not include enough detail on the imagery intervention used (Barreca et al., 2003; Bell & Murray, 2004; Braun et al., 2006; Langhorne et al., 2009; Malouin et al., 2013; Munzert et al., 2009; Schuster et al., 2011; de Vries & Mulder 2007; Zimmermann-Schlatter et al., 2008). For example Liu et al. (2004a) included action observation and task analysis of ADL during their imagery intervention while in the study by Dunsky et al. (2008) imagery of walking occurred. Out of all the studies included in the meta-analysis only one study (Dunsky et al., 2008) published the imagery intervention script that was used. It would have been interesting to know what was said during the audio-tape imagery to enable therapists to replicate the intervention (Page 2000; Page et al., 2001a; 2007).

3.4.7. Study limitations. Several factors have limited the results of this study. Firstly, some of the articles found during the literature search only displayed numerical data in the format of figures. This prevented the data from being extracted, therefore, reducing the number of studies that could be used in the meta-analysis. Many of the studies did not provide enough detail regarding the content of the imagery intervention and when it was performed, consequently, preventing the identification of key factors that influence imagery. Finally, by authors presenting group data any inter-individual variations that might have occurred following imagery due to factors such as stroke severity and location of stroke were masked. Factors that could affect imagery effectiveness could be more easily identifiable in case study research.

3.4.8. Conclusion. This meta-analysis found a moderate mean treatment effect of imagery on upper- and lower-limb movement ability in post-stroke rehabilitation. This suggests that imagery can have a positive effect on movement ability during stroke rehabilitation, but the magnitude is quite limited. However, the high standard deviation and confidence values reflect the fact that there was considerable variability in the results of the included studies. Unfortunately, due to the lack of detail provided regarding the actual content of the imagery interventions, it is impossible to determine the key factors that influence imagery's effectiveness. Imagery seems to be more effective in improving gait than upper-limb ADL. Imagery that is performed during physical therapy, includes a third person visual perspective, action observation and task analysis seems to be more effective at improving ADL. Age of participants, intervention time post-stroke, duration of therapy, duration and frequency of imagery, imagery perspective and whether imagery was performed with, after or without physical practice did not predict imagery's effectiveness. It is urged that when reporting the results of imagery and stroke rehabilitation research that sufficient detail is provided to enable other researchers and therapists to fully evaluate and replicate the work.

It is interesting to see that therapists are not involved in the research conducted on cognitive therapy use post-stroke. This could be because experimenters are not seeking therapists' advice and are conducting their research independently, or therapists are not using cognitive therapies. Therefore, it is important to ascertain whether therapists are using cognitive therapies, and if so, how they are implemented. The meta-analysis solely focused on the use of imagery during stroke rehabilitation but as mentioned in chapter two, mirror box therapy and action observation could be used during therapy sessions to promote the re-learning of tasks and improve movement. Imagery could benefit from being performed alongside action observation and mirror box therapy post-stroke, as following a stroke image generation can be affected and the content of imagery is hard to control (Holmes, 2007). Therefore, study two reports an investigation on therapists' use of imagery, mirror box therapy and action observation during stroke rehabilitation.

Chapter Four: MPhil Study Two

The Use of Cognitive Therapies by Physiotherapists and Occupational Therapists during Stroke Rehabilitation

4.1. Introduction

Cognitive therapies are a potential way of improving movement performance post-stroke, as they are practical, inexpensive and can be performed by patients independently. The results of the meta-analysis highlighted the possible advantages of using imagery with physical practice to aid improvements in movement. Even though a moderate treatment effect of 0.48 was found, there was a large variation in the between-participant treatment effect from 1.46 (Verma et al., 2011) to -0.33 (Boverd'Eerdt et al., 2010). Imagery seems to be more beneficial at improving upper-limb ADL when combined with action observation and task analysis.

4.1.1. Benefits of using cognitive therapies during stroke rehabilitation. The benefits of the use of imagery during stroke rehabilitation are that imagery help increase the number of repetitions during a therapy session in a safe manner and without excessive physical fatigue (Malouin, Jackson, & Richards, 2013). Imagery can also allow a patient to mentally rehearse a motor task whenever and wherever they want, as well as more demanding tasks such as walking (Malouin et al., 2013). As previously stated, the results of the meta-analysis found that some imagery interventions produced significant improvements in movement (Verma et al., 2011; Santos-Couto-Paz et al., 2013; Liu et al., 2004a; Page et al., 2001a; 2007) which would allow stroke-affected individuals to become more independent. Only limited equipment, such as picture cards is needed during imagery to help image vividness and to facilitate the identification of task sequence order (Liu et al., 2004a). Audio recordings could enable stroke-affected individuals to perform imagery independently (Page et al., 2005) and imagery scripts would help monitor the activities that are being imaged. As imagery does not require physical movement it can be used when little or no movement is possible (Tamir et al., 2007). In addition, aspirational tasks that the stroke-affected individual cannot currently perform could be imaged to provide neural (Munzert & Zentgraf, 2009) and muscular (Wilson et al., 2010) stimulation.

Mirror box therapy is another cognitive therapy that has been reported to improve movement ability in both the upper- and lower-extremities following stroke (Yavuzer et al., 2008; Sütbeyaz et al., 2007). Mirror box therapy during stroke rehabilitation involves performing bilateral arm movements while the impaired limb is obscured from sight by the box. The patient watches the movement of the unimpaired limb in the mirror reflection, thus giving the illusion that the impaired limb is moving unaffected with enhanced movement capability. An advantage of mirror box therapy is that it is easy to administer, enabling patients to self-administer the therapy at home. Mirror box therapy has also been shown to have a lasting effect on motor function with improvements lasting six months after the intervention (Michielsen et al., 2011).

Action observation has been reported to aid stroke rehabilitation as the observation of movements with the intent to imitate increases cortical excitability of the primary motor cortex (Gangitano, Mottaghy, & Pascual-Leone, 2001), and improves motor function (Ertelt et al., 2007). Interventions combining action observation and physical therapy by Ertelt et al. (2007) and Franceschini et al. (2010) have also found significant improvements in motor function. Ertelt et al. (2007) also found that action observation increases activation levels in large areas of the sensorimotor network when manipulating objects in both the affected and unaffected hand. To enhance motor training after stroke, action observation interventions need to involve participants observing actions in the same orientation and direction as physical performance (Celnik et al., 2008). Research by Frak, Paulignan, and Jeannerod (2001) suggests that during imagery images should also be imaged in the same orientation and direction as physical performance, as awkward movements take longer to image.

As well as the direct neural effects of such interventions, they may have beneficial effects upon patients' motivation that may impact the effectiveness of their rehabilitation. The following section will therefore examine the issue of motivation during stroke rehabilitation.

4.1.2. Patient motivation during stroke rehabilitation. Following a stroke, individuals become demotivated when they are unable to cope with their new disability. Healthcare professionals regard motivation as being a key factor in the rehabilitation process as it can affect rehabilitation outcomes (Maclean et al., 2000). A patient's level of motivation is very important as patients who are highly motivated play more of an active role in their rehabilitation (Maclean et al., 2000)

Motivation has been intensively investigated in the sport science literature and has identified that low levels of motivation can result in individuals avoiding difficult tasks, consistently not working hard and giving up when tasks become difficult (Atkinson, 1974). The research by Maclean et al. (2002) investigated how therapists motivate patients and the results are similar to how coaches motivate athletes (Kyllo & Landers, 1995; Biddle, et al., 2001). Therapists said they increased motivation by setting relevant rehabilitation goals, providing information about rehabilitation and providing encouragement (Maclean et al., 2002). However, it is unknown whether therapists use cognitive therapies to motivate their patients. It is also unclear whether other motivational techniques such as attributing improvements in movement to factors that are within the patients control (Weiner, 1985; 1986), and whether patients are motivated to achieve success (Atkinson, 1974) are used by therapists to increase patients' motivation levels. If therapists are found to use cognitive therapies to improve motivation, this information will highlight a possible need for cognitive therapies to be included in clinical guidelines for motivational reasons.

4.1.3. Study two rational. At present imagery is the only cognitive therapy included in the National Clinical Guideline for Stroke (Intercollegiate Stroke Working Party, 2012). The guidelines on the use of imagery during stroke rehabilitation lack detail and clarity. For example, the National Clinical Guideline for Stroke (Intercollegiate Stroke Working Party, 2012) recommends that patients should be encouraged to use imagery alongside conventional therapy to help improve arm function. However, no information is given regarding how imagery should be performed. More detail is needed in clinical guidelines regarding duration and frequency of therapy, therapy content and therapy delivery. This will enable the standardisation of effective cognitive therapy practice.

Even though there is evidence that imagery, mirror box and action observation can aid stroke rehabilitation, it is not known whether and to what extent physiotherapists and occupational therapists use these therapies in their current practice and how they use them. Determining how cognitive therapies are being implemented will enable comparisons to be made between current clinical practice and recommendations for clinical practice in the literature. This will enable recommendations to be made to facilitate improvements to be made to clinical practice. It is important to know therapists' thoughts and feelings regarding the use of cognitive therapies during stroke rehabilitation. This will help identify any constraints therapists are encountering that prevents them from implementing cognitive therapies during their current clinical practice or impact its effectiveness. The identification of constraints will enable procedures to be put in place to help facilitate therapists' use of cognitive therapies. It would also be beneficial to know whether therapists who are using cognitive therapies find them advantageous to improving movement. The information provided by the therapists regarding their use of cognitive therapies is pivotal in the construction of detailed clinical guidelines.

To summarise, there is evidence that mirror box therapy and action observation can aid stroke rehabilitation as well as imagery, but it is not known whether and to what extent physiotherapists and occupational therapists use these therapies in their current practice and how they use them. Investigating these issues will give an insight into how therapists perceive the usefulness of cognitive therapies in stroke rehabilitation and whether they require more research evidence before using them in their current practice. The potential issues and problems in therapists' use of cognitive therapies will help inform and enable the production of clinical guidelines on the use of imagery, mirror box therapy and action observation during stroke rehabilitation. Therefore, the aim of study two was to conduct a national skill audit to investigate the extent to which physiotherapists and occupational therapists in the UK use imagery, mirror box therapy and action observation during stroke rehabilitation, to discover how these are conducted and to explore therapists' views. Study two also examined how physiotherapists and occupational therapists motivate stroke patients through the use of cognitive therapies. As previously mentioned a hypothesis was not stated due to the exploratory nature of the study.

4.2. Method

4.2.1. Participants and procedures. Prior to data collection ethical approval was obtained from the Institution's Ethics Committee; see Appendix G for ethical acceptance letter. The skill audit was posted to 247 NHS physiotherapists and 247 occupational therapists across England, Wales and Northern Ireland. For all 247 NHS hospitals that had a stroke unit in England, Wales and Northern Ireland (according to

SINAP [2011]) a skill audit was posted to the senior physiotherapist and occupational therapist working in the stroke unit. Stroke units were eligible to be included in SINAP if they treated at least 10 stroke patients in a year; therefore, they include every stroke unit in England, Wales and Northern Ireland. Unfortunately, addresses for stroke units in Scotland were unable to be obtained. Money was also budgeted to send skill audits to private physiotherapists and occupational therapists working in the North West of England. Skill audits were sent to 49 private physiotherapists and 21 private occupational therapists working in North West England. Private physiotherapists and occupational therapists in the North West were identified from the phone directory. Cognitive therapy delivery by both NHS and private therapists wanted to be captured, but on reflection, the skill audit maybe should have only focused on NHS therapists as few private therapists replied.

Surveys can be conducted in person, on the phone, by mail or over the internet (Blair et al., 2014). Research by Sinclair, O'Toole, Malawaraarachchi, and Leder (2012) when comparing response rates and cost-effectiveness of postal, internet and telephone surveys found postal surveys to be the most economic option. The survey was therefore posted to the senior physiotherapist and occupation therapist, as they are likely to dictate the therapy approaches used in the stroke unit. A physiotherapist on the advisory team for the skill audit mentioned that posting the survey would be beneficial because therapists do not always have access to a computer when on the ward. A paper copy of the survey would enable therapists to easily keep it with them and fill it in when in-between patients on the ward. The colour of the paper used for the survey was yellow, so it would stand out from their normal paper work and remind them to complete it.

Therapists were also able to complete the survey online. Advantages of an online survey are that data quality can be improved with prompts for answers to missed questions. Online data entry could also be less time-consuming as irrelevant sections could be automatically skipped resulting from answers to previous questions (Sinclair et al., 2012). Unfortunately, it was not possible for email addresses to be obtained, so therapists had to go online and type in the web address, instead of quickly clicking on a link in an email. Most therapists chose to post back their replies in the pre-paid envelope provided. A pre-paid envelope with the return address was provided to try to increase response rates by making it easy for therapists to reply. The skill audit was posted to therapists at the beginning of November 2011 and replies were received until the beginning of February 2012.

4.2.2. Development of the skill audit. The questions for the skill audit were based on key factors that the literature suggests determine the effectiveness of imagery, mirror box therapy and action observation. These key factors include frequency and duration of therapy sessions, how the therapies are delivered, how the content of the therapy sessions is chosen, what the content of the therapy sessions includes and visual perspectives used. The effect of these key factors on imagery have previously been included in the literature review section 2.4.3 starting on page 34. Information about the effect of these key factors on mirror box therapy and action observation can be found below.

4.2.2.1. Frequency and duration of therapy sessions. In the stroke rehabilitation literature frequency and duration of imagery, mirror box and action observation vary greatly. When mirror box was performed for 30 minutes five times a week (Sütbeyaz et al., 2007; Yavuzer et al., 2008) significant improvements in movement occurred. The duration of effective action observation sessions was longer than that of imagery and mirror box therapy. Action observation that lasted 31-40 minutes more than three times a week has been found to serve as a motivating agent and to significantly improve motor function (Ewan et al., 2010a; Franceschini et al., 2010). By finding out how often and how long cognitive therapy sessions are, therapists' current clinical practice can be compared with reported effective therapy delivered in the literature. If there are differences in cognitive therapies' duration and frequency between current clinical practice and the literature, this will highlight the need for further research to investigate why therapists are not using recommended therapy durations and frequencies. In addition, it will highlight the importance of the development of clinical guidelines to educate therapists about effective cognitive therapy delivery.

4.2.2.2. How therapy sessions are delivered. Cognitive therapy interventions in the literature are predominantly led by a therapist but participants are also asked to participate in some of the therapy sessions independently, for example in Page's (2000) imagery study. According to attribution theory (Weiner, 1985), if people feel in control of their physical performance then they experience increased motivation. If people affected by stroke are allowed to help choose the content of therapy sessions and perform them without the aid of a therapist, this could enable patients to feel more in control of their rehabilitation, leading to increased levels of motivation, felling more empowered and engaged with their therapy sessions. Researchers have not yet investigated whether therapists allow patients to perform imagery, mirror box therapy and action observation by themselves at home. Therefore, questions regarding whether patients are allowed to perform cognitive therapies independently were included in the skill audit.

4.2.2.3. How the content of the therapy sessions is chosen. When cognitive therapy interventions are investigated in stroke-affected individuals, researchers base the interventions on ADL that are being practiced during physical therapy (Liu et al., 2009). Therapists need to make sure that patients are physically practicing ADL that they aspire to improve and perform unaided in the future. Personalisation is important as research by Wilson et al. (2010) found that in healthy individuals personalised imagery produced significantly greater muscle activation in task-relevant muscles than an experimenter generated script. Therefore, if patients are allowed to choose the activities they image, observe and perform then they are likely to experience greater levels of muscle innervation than activities chosen by the therapist. The skill audit therefore asked therapists how the content of the therapy sessions was chosen.

4.2.2.4. What the content of the therapy sessions includes. It is also unknown what therapists ask patients to focus on when they are performing cognitive therapies. For example, during action observation patients might be asked to focus on the visual aspects of the movement and/or the kinaesthetic feeling of the movement. Combining vision and kinaesthetic feeling provides a multi-sensory experience that would inform patients of how correct movement patterns should be performed. It is also unknown whether therapists write down what they require their patients to image and if an audio recording is used. Writing imagery scripts and using audio recordings would enable patients to perform imagery independently. Imagery scripts and audio recordings would help monitor the activities that are being imaged.

The brain damage following a stroke can inhibit individuals from being able to distinguish between their left and right side of the body (Bowering et al., 2013). Flash cards can be used before every mirror box therapy session or until patients can distinguish between the left and right side of their body. Each flash card contains a picture of a single limb (e.g., a hand) from either the left or right side of the body. The flash cards also include pictures of limbs in different orientation. The patient then has to identify whether the picture is of a limb from the left or right side of the body. The use of flash cards to train laterality has been found to activate premotor cortices and re-establish left and right concepts in the brain (Moseley, 2004). Flash cards are also used when measuring imagery ability during image rotation tasks (de Vries et al., 2011). During mirror box therapy patients need to be able to recognise that the reflection in the mirror represents their affected limb and that their affected limb is either on the left or right side of their body. Laterality training is the first stage of Graded Motor Imagery (GMI), which is used in the treatment of phantom limb pain (Priganc & Stralka, 2011). This is because it is thought that until patients can accurately distinguish between the left and right side of their body cortical retraining would be counterproductive (Priganc & Stralka, 2011).

During mirror box therapy with individuals who suffer from phantom limb pain, patients move their unaffected limb into an uncomfortable position then relax (Ramachandran, 1994). The reflection of the unaffected limb gives the illusion that the phantom limb is relaxed thus reducing levels of phantom limb pain. It is unknown whether therapists are using mirror box therapy to reduce limb pain post-stroke. That is why therapists were asked whether they get patients to move limbs into uncomfortable positions during mirror box therapy. Knowing what activities therapists are using during cognitive therapies in stroke rehabilitation will help inform clinical guidelines.

Resistance training has been found to improve walking patterns, increase strength and self-reported function in individuals affected by stroke (Teixeira-Salmela, Nadeau, Mcbride, & Olney, 2001; Ouellette et al., 2004). At present, no research has investigated whether the use of resistance aids during mirror box therapy improves muscle strength and function. This is surprising as it is common for resistance aids to be advocated during exercise training post-stroke (Dobkin, 2008). It would therefore be interesting to know whether therapists are using resistance aids during mirror box therapy, even though research has not yet investigated their efficacy.

4.2.2.5. Visual perspective used during therapy sessions. Varying visual perspectives have been used when investigating the effect of imagery and action observation on performance post-stroke. Improvements in movement have been reported when observing video clips that show ADL performed from both a first person and third person visual perspective (Chatterton et al., 2008; Ertelt et al., 2012). However, research by Ewan et al. (2010b) found that individuals affected by stroke had less vivid first person imagery and kinaesthetic imagery than healthy controls, but were significantly better than healthy controls at performing third person imagery. It is therefore important to know whether therapists are asking patients to perform imagery and action observation from a specific perspective, and if they know whether patients might experience difficulty observing and performing imagery from a first person visual perspective.

4.2.3. Piloting of the skill audit. To ascertain whether the questions in the skill audit were appropriate it was pilot tested at Pennine Acute Hospital NHS Trust prior to distribution. During pilot testing a questionnaire and a copy of the skill audit was sent to 30 physiotherapists and 30 occupational therapists; a pre-paid envelope was sent to enable the replies to be posted back. The questionnaire established: (1) how long it took to complete the skill audit; (2) whether therapists were able to complete the skill audit online; (3) whether any of the questions were ambiguous; (4) whether any of the questions were unnecessary; and (5) whether the layout of the skill audit was attractive and clear. A copy of the questionnaire can be found in Appendix H. Therapists had the option of responding yes or no to the pilot questions and under each pilot question there was a space for therapists to add comments and suggestions about the skill audit. A copy of the imagery in stroke rehabilitation skill audit, that was piloted, can be found in Appendix I.

Six physiotherapists and three occupational therapists completed the questionnaire and skill audit. The mean time taken by therapists to complete the skill audit was 14 minutes. The therapists commented positively on its layout and attractiveness, and none of the therapists were offended by any of the questions or objected to answering any of them. The therapists thought that the questions were relevant to the study title and that the instructions at the beginning of the skill audit were clear. One therapist had difficulty logging on to the on-line version of the skill audit. The therapist then commented that the web address was too long, and suggested that a simpler site name should be used. In response to the comment, the web address was shortened. Five therapists did not understand the terminology of cognitive therapy types. The therapists recommended that each cognitive therapy type should include an example. Resulting from most of the therapists not knowing the different types of cognitive therapies included in the skill audit the second part of question eight was removed and definitions for imagery, mirror box therapy and action observation were provided. The list of different cognitive therapies was also excluded because the focus of the skill audit changed to specifically looking at therapists' use of imagery, action observation and mirror box therapy.

Following piloting, all the comments were reviewed and some additional changes were made to the final version of the skill audit in response to the feedback. These changes included also investigating therapists' use of mirror box therapy and action observation. These two therapies were also included because of positive findings on improving movement in the literature; see the introduction to study two for a summary of the literature. Also added to the skill audit were questions asking which cognitive therapy they find the most effective in improving hand function and which is the most effective in improving leg function. Therapists were asked about which visual perspective they use when conducing an action observation session. Two new questions were added asking therapists about whether they use imagery, mirror box therapy or action observation to motivate patients and if so how they do this. Part C of the final skill audit was completely new and included specific questions about therapy sessions. For example, therapists were asked what they emphasised when using imagery (e.g., physical movement used in therapy sessions, ADL or goal setting) and do they develop a written imagery script. Specific questions about mirror box therapy sessions included whether flash cards were used at the start of every therapy session or just until they could distinguish between left and right. Questions about patients performing uncomfortable positions, bilateral movements and resistance aids during mirror box therapy were also included. During pilot testing the therapists approved the content of the skill audit, therefore, providing some evidence of the face validity of the questionnaire.

4.2.4. Structure and content of the skill audit. The response format of the skill audit was predominantly in a tick box format, allowing therapists to tick the category that was most applicable to their clinical practice. The tick box format also aimed to reduce the completion time of the skill audit. There were also three open-ended questions that enabled therapists to comment on: (1) what workshops they had attended; (2) how they motivate patients through the use of cognitive therapies; and (3) any additional information about their therapy practice. Therapists were asked about what workshops they had attended to determine whether there are specific workshops on the use of cognitive therapies during stroke rehabilitation, or whether such therapies are being mentioned for a limited amount of time during workshops that focus on other therapy techniques. Therapists were asked how they use cognitive therapies to motivate patients because motivation can affect the amount of effort a patient exerts during rehabilitation and whether they will adhere to therapy (Sage, 1977). This enabled the identification of therapists' motivational techniques, therefore, identifying whether therapists require more guidance on how to improve patients' motivation. Therapists were provided with an opportunity for to include any addition information and gave them the chance to add any important information that they deemed was not answered during the skill audit.

The skill audit consisted of 30 questions in total that were split into three sections; see Appendix D. Section one contained questions relating to demographic information. These included: whether participants were physiotherapists or occupational therapists, their pay scale, how long they had been qualified/working in stroke rehabilitation and how many hours in a typical working day participants spent working directly face-to-face with stroke patients.

The first half of section two explored which cognitive therapies participants used and where they were educated in the use of these therapies. In the current study cognitive therapy was defined as structured therapy that attempts to change positively the patient's thoughts, emotions and behaviours. There may be associated changes in physical function and behaviour. The cognitive therapy definition was provided at the beginning of the skill audit and was developed from Beck et al.'s (1979) description of cognitive therapy. The questions asked where participants had first heard of and learned about imagery, mirror box therapy and action observation and whether they had attended any relevant workshops. The second half of section two contained generic questions on the use of imagery, mirror box and action observation during stroke rehabilitation. Items included the percentage of stroke patients that received the therapies, therapy duration, frequency, content and mode of delivery. Examples of these questions are: "Was the therapy delivered by the health care professional, the patient outside of formal therapy sessions or both? With approximately what percentage of stroke patients do you use imagery, mirror box or action observation?" Participants were asked when conducting imagery and action observation what visual perspective (first or third person) their patients imaged from. Participants were also asked who chooses the content of the therapy sessions and what is the content based upon (e.g. past experiences, present activities or future aspirational activities): "Who chooses the content of the imagery, mirror box therapy or action observation, you, the patient or both? What was the content of the imagery, mirror box therapy or action observation based upon, past experiences, present activities or future aspirational activities?"

Section three included specific questions about imagery and mirror box therapy. Therapists were asked what they emphasised when administering imagery interventions (physical movement in therapy sessions, activities of daily living, goal setting, physical motivation, visual and/or kinaesthetic imagery [what patients see and feel when physically performing the task]). Therapists were asked whether they develop written imagery scripts, whether they use flash cards during mirror box therapy and if patients are asked to visualise themselves moving their hand into uncomfortable positions. Information was obtained regarding therapists' use of resistance aids and the performance of bilateral movements during mirror box therapy. Therapists who did not currently use the cognitive therapies were also asked if they would consider using imagery, mirror box therapy and action observation as a supplement to physical therapy sessions with guidance.

A survey enables the collection of information from a predefined population (Blair, Czaja, & Blair, 2014) and provides a snapshot of therapy practice at a specific time (Denscombe, 1998). A survey was used to investigate therapists' use of cognitive therapies during stroke rehabilitation because it enabled large amounts of information to be obtained regarding therapy delivery from many therapists in a short amount of time and for a fairly low cost (Kelley, Clark, Brown, & Sitzia, 2003). The Research and Design manager at Pennine Acute NHS Hospital Trust and a physiotherapist provided advice on the content of the skill audit. They suggested that the first section should include questions that collect the therapists' demographic information, such as their level of experience and how long they have been working in stroke rehabilitation. Prior to and following piloting, the advisory group commented on several drafts of the skill audit regarding the content and wording of the questions, appearance and the format of the skill audit. They advised on whether the therapists would understand the terminology used and suggested categories provided for responses (e.g., Agenda for Change pay scale bands 5, 6, 7, 8a and 8b).

It was decided that the majority of the questions were to be in a closed-ended tick box format, so therapists could quickly respond to specific aspects of their therapy delivery. Three open-ended questions were included to provide a direct view into therapists' thoughts regarding workshops attended, motivating patients and any other thoughts. An advantage of closed-ended questions is that large amounts of data can be analysed quickly, but open-ended questions allow therapists to express any additional thoughts about cognitive therapies that completing the survey had evoked (Roberts, 2014). A deductive approach was used when developing the content of the skill audit, as the questions were based on key factors that the literature suggests determine the effectiveness of imagery, mirror box therapy and action observation.

Some problems were encountered when conducting the study and include the skill audit not being returned or being returned incomplete. During the open-ended questions some therapists did not provide any information and when completed most responses lacked detail and depth. In some cases, it was difficult to read the therapists' handwriting and unknown abbreviations were used. When unknown abbreviations were used, a physiotherapist who was advising on the project was contacted and she was able to inform what the abbreviation stood for, but this took extra time. A major disadvantage of surveys is it is difficult to know whether respondents are truthful (Kelley et al., 2003). As the responses were anonymous, it is probable that therapists felt comfortable to give an accurate reflection of their current clinical practice.

4.2.5. Data analysis

4.2.5.1. Quantitative data analysis. Most of the questions were in a tick box format. The data obtained from the skill audit were inputted into IBM SPSS Statistics (version 19) software, to enable descriptive statistics including frequency, percentages and mode data to be calculated from the raw data. Correct data entry was assessed by checking all the raw data then re-checking 10% of the skill audits for mistakes. When mistakes were found they were corrected then another 10% of the skill audits were checked. Data checking continued until no mistakes were found. Not all therapists completed every question as they did not all use imagery, mirror box therapy and action observation during stroke rehabilitation. Therefore, the total number of therapists answering each question varied, so in the results section the total number of therapists used to calculate each percentage is detailed. Physiotherapists' and occupational therapists' results were compared and the majority of the results were similar between the two groups. Therefore, the findings between therapists were only reported separately when differences had been found.

4.2.5.2. Qualitative data analysis. Unlike the quantitative approach used to analyse most of the questions the three open-ended questions were analysed qualitatively. The therapists' responses were transcribed and the content was analysed using a deductive approach (Burnard, Gill, Stewart, Treasure, & Chadwick, 2008). A deductive approach was used as there is already previous knowledge in: (1) the sporting and stroke literature regarding the effects of motivation; and (2) the investigation of cognitive therapies during stroke rehabilitation which informed the identification of emerging themes and categories. In addition, only information that was related to the skill audit question, for example motivation, was included in the data analysis. Therapists' comments were analysed through thematic content analysis (Pope, Ziebland, & Mays, 1999). Thematic content analysis involves the identification of emerging themes and categories that become known through the data (Pope, Ziebland, & Mays, 1999). Therapists' responses were first read closely to aid in familiarisation of the raw data and to identify emerging themes, through open coding. Emerging themes included any information regarding therapy practice.

The emerging themes were verified and confirmed by searching through the data and repeating the process on numerous separate occasions, by only the author; see Appendix K. On reflection, thematic analysis may not have been appropriate, as the therapists were primed to answer specific questions. In addition, the majority of therapists only responded with a single sentence. Thematic analysis is normally used to analyse interview transcripts by extracting numerous themes, which are later grouped together if they are similar. Therefore, giving a detailed account of the topic being investigated. Some experts in the field of qualitative research have argued that a single individual conducting the thematic analysis is both sufficient and preferred (Janesick, 2003; Morse & Richards, 2002). This is particularly true when the researcher is embedded in an ongoing relationship with the participants. In these cases, the data collection and analysis are so intertwined that they should be conducted by a single person (Janesick, 2003). However, as there was no relationship between the author and the therapists it may have been more beneficial to have a team of researchers involved in the qualitative analysis, as suggested by Pope, Ziebland, and Mays (2000), to improve the depth of the analysis and findings. In addition, people have differing experiences, traditions and paradigms which makes the repeatability of a study difficult when one individual is involved in the data analysis, as research bias can occur (Bradley, Curry, & Devers, 2007). However, there were few qualitative questions to analyse, so involving a team of researcher may have been excessive and result in multiple themes being derived from a small data set. The data was also revisited on several occasions to improve the reliability of the analysis.

Associations were found between the emerging themes to produce categories that included similar or over-lapping information (Burnard et al., 2008). The first categories were formed from the emerging themes and termed first order data themes. Only similar emerging themes (events and comments) were grouped together as first order data themes. The second categories were formed from the combination of similar first order data themes to produce categories that are termed second order data themes. The aim of grouping data was to diminish the number of categories; therefore, aiding in the identification of the main concepts, thus increasing understanding (Burnard, 1991; Cavanagh, 1997). The formation of the categories was informed by theoretical ideas developed from the literature. The final stage of data analysis involved interpretation of the categories to define concepts.

4.3. Results

4.3.1. Demographic data. The skill audit was distributed to 564 therapists. One hundred and forty-two therapists completed the skill audit, which is a response rate of 25% (62 occupational therapists and 80 physiotherapists). The therapists' mode Agenda for Change pay scale, which is the UK National Health Service pay scale, was band seven (£30,460 - £40,157 per year in 2011/2012). Occupational therapists had been qualified for more than 20 years while physiotherapists had been qualified 6-10 years.

The therapists had been involved in working with stroke patients for 6-10 years with occupational therapists spending greater than five hours and physiotherapists spending 3-5 hours in a typical 7.5 hour working day, working directly face to face with stroke patients.

4.3.2. Cognitive therapy education. Out of the 142 therapists that replied to the skill audit 97% (138) had heard of imagery. Ninety-seven percent of therapists had heard of mirror box therapy, while fewer therapists had heard of action observation (85/142, 60%). Therapists first learned about imagery and action observation during postgraduate training. While mirror box therapy was learned first during postgraduate training and also from their colleague(s); see Figure 4.1.

Eleven physiotherapists and six occupational therapists (17/142, 12%) had attended a workshop about imagery, mirror box therapy and action observation. The number of emerging themes that were used as the foundation of the thematic content analysis during the workshop question was 18. The 18 emerging themes included any information provided by the therapists regarding cognitive therapy workshops that they had attended. During the thematic content analysis similar information, from the emerging themes, was then grouped together to form categories (Pope et al., 1999). Four therapists reported that they had received in house training and one therapist received mirror box training when partaking in a mirror box therapy study. Most of the workshops were not specifically aimed at imagery, mirror box therapy and action observation but were looking more widely at how to improve upper-limb functioning and motivation during stroke rehabilitation.

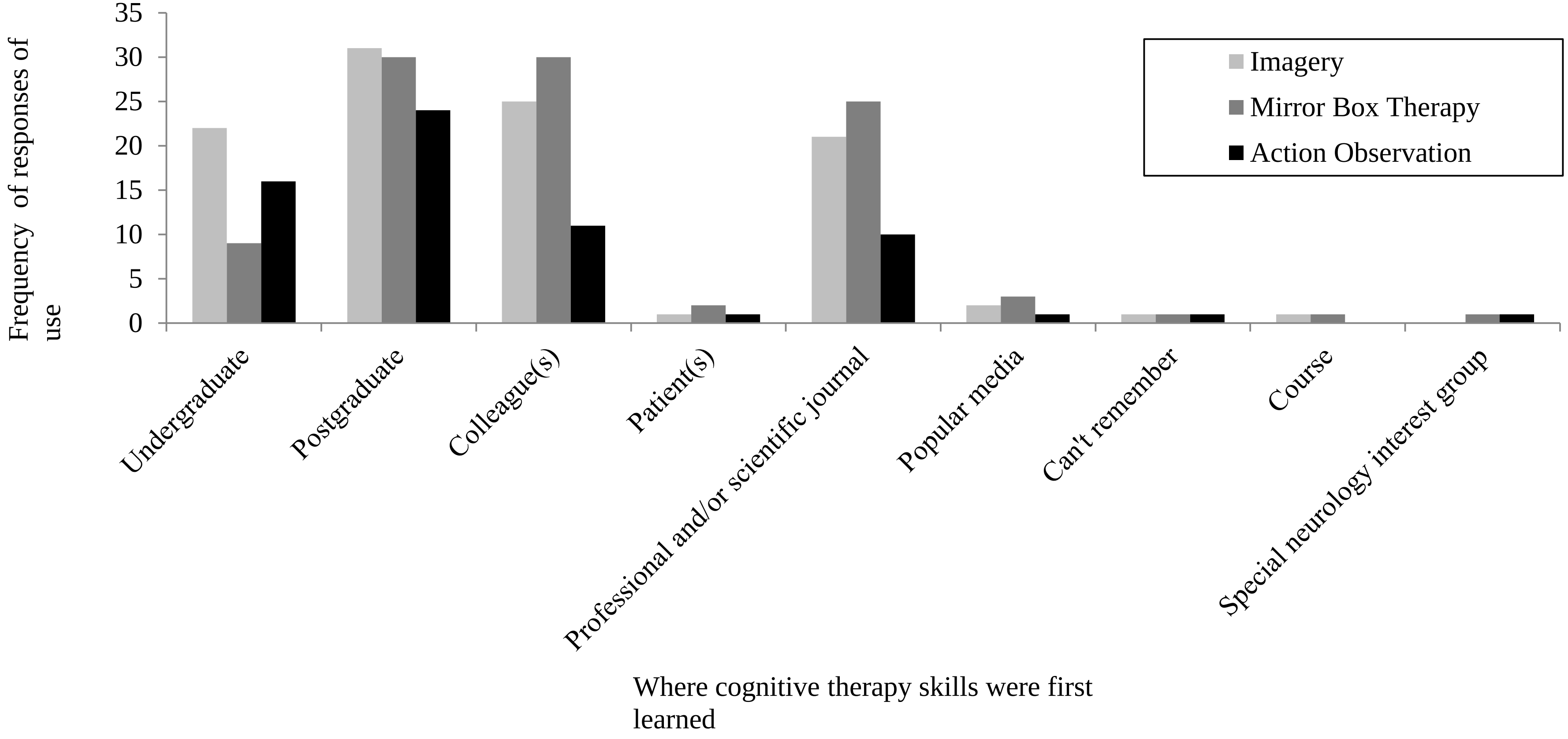


Figure 4.1. Frequency of therapists' responses regarding where cognitive therapy skills were first learned.

Out of the three therapies being investigated, 68% (91/133) of therapists had used imagery, 53% (68/129) action observation and 41% (52/128) mirror box therapy. The next section of the results will go into more detail about how imagery, action observation and mirror box therapy sessions were conducted. To increase the clarity of which question of the skill audit the findings came from, the question number will be in brackets.

4.3.3. Imagery. Therapists reported that they would administer imagery with approximately 1-20% of their stroke patients (Q15). With a typical stroke patient, therapists administered imagery one session per week (Q16).When led by a physiotherapist imagery sessions most often lasted for 1-10 minutes, while sessions led by an occupational therapist lasted for 21-30 minutes (Q17). Fifty-seven percent of therapists (51/89) reported that imagery was delivered by a health care professional and by the patient outside of formal therapy sessions (Q18). The content of the imagery session was most often chosen by occupational therapists but physiotherapists mentioned that the patient also helps them choose the content of the imagery (Q20). Patients were most often asked to image from a first person visual perspective (Q19) and the content of occupational therapy imagery sessions was based upon past experiences while physiotherapy sessions were based upon past experiences and present activities (Q21). During imagery sessions, therapists emphasised imagery of physical movement used in therapy sessions as well as imagery of ADL (Q24). Eighty-two percent (69/84) of therapists reported they did not develop a written imagery script (Q25) and imagery was also used by 79% (72/91) of therapists to motivate patients (Q22). Out of the 42 therapists that reported that they did not use imagery, 30 therapists (71%) would consider with guidance using imagery as a supplement to their physical therapy sessions (Q30).

4.3.4. Mirror box therapy. Therapists reported that they administered mirror box therapy with approximately 1-20% of stroke patients (Q15). With a typical stroke patient, mirror box therapy was administered by physiotherapists once a week and by occupational therapists twice a week, for 11-20 minutes (Q16 and Q17). Therapists commented that this therapy was delivered by both a health care professional and by the patient outside of formal therapy sessions (Q18). Most physiotherapists solely choose the content of the mirror box therapy sessions while occupational therapists allowed patients to help develop the mirror box therapy content (Q20). The content of the mirror box sessions was mainly based upon present activities (Q21).

Out of the 52 therapists that used mirror box therapy only five therapists (9.6%) used flash cards at the start of every mirror box therapy session, to teach patients the distinction between left and right sides of the body, and three occupational therapists used flash cards until they could make this distinction (Q26). Out of the 52 therapists that reported they used a mirror box, only 14 therapists (27%) had patients visualise themselves moving their hand into positions that they might find uncomfortable (Q27). Therapists had patients perform bilateral movements (Q28), but therapists did not used resistance aids during mirror box therapy sessions (Q29). Mirror box therapy was also used by 69% (36/52) of therapists to motivate patients (Q22). Out of the 76 therapists that reported that they did not use mirror box therapy, 58 therapists (76%) would consider with guidance using mirror box as a supplement to their physical therapy sessions (Q30).

4.3.5. Action observation. Therapists have reported administering action observation during stroke rehabilitation sessions with approximately 1-20% of stroke patients (Q15). With a typical stroke patient action observation was administered once a week by occupational therapists or more than three times a week by physiotherapists (Q16). Action observation sessions lasted for 1-10 minutes when led by an occupational therapist or 31-40 minutes when led by a physiotherapist (Q17). Therapists stated that action observation was most often only delivered by a health care professional (Q18) and the content of therapy sessions was chosen solely by physiotherapists, while occupational therapists allowed patients to also choose the content (Q20). During action observation patients were most often asked to image from a first person visual perspective (Q19) and the content was based upon present activities (Q21). Action observation was also used by 75% (51/68) of therapists to motivate patients (Q22); this issue will be further explored in the qualitative analysis. Out of the 61 therapists that did not use action observation, 46 (75%) therapists would consider using action observation under guidance as a supplement to their physical therapy sessions (Q30).

4.3.6. Comparisons between cognitive therapies. Differences in therapy session delivery were found between imagery, action observation and mirror box therapy (Q16 and Q17). More action observation sessions were performed during an average week than imagery and mirror box therapy. The duration of a single mirror box session was also longer than an imagery or action observation session; see Table 4.1.

Table 4.1

Duration and Frequency of Imagery, Mirror Box Therapy and Action Observation

	Therapist mode response
Number of imagery sessions a week	1
Number of mirror box therapy sessions a week	1
Number of action observation sessions a week	>3
Duration of imagery sessions (min)	1-10
Duration of mirror box therapy sessions (min)	11-20
Duration of action observation sessions (min)	1-10

Differences between therapies were found regarding how therapists delivered imagery, action observation and mirror box therapies and the content of the sessions (Q18 and Q21). Imagery and mirror box were being delivered by both the health care professional and by the patient outside of formal therapy sessions. Action observation was only being performed by the health care professional. Differences found between therapy content were that Mirror box and action observation sessions were based upon present activities that the patients could perform, while imagery was also based upon past activities.

The skill audit data were analysed to determine how many therapists perform only imagery, mirror box therapy or action observation, or whether they used more than one cognitive therapy. The most popular combination of cognitive therapies, by therapists, was imagery and action observation (31/109, 28%). Twenty-two percent (24/109) of therapists performed all three cognitive therapies during stroke rehabilitation, while 18% of therapists solely used imagery (20/109). Sixteen percent (17/109) of therapists performed both imagery and mirror box therapy, but only six percent (7/109) used mirror box therapy and action observation or action observation on its own. Finally, only four percent (4/109) of therapists only performed mirror box therapy during physical therapy sessions. The results above show that a single cognitive therapy was more often than not performed in combination with another cognitive therapy.

4.3.7. How therapists motivate patients. Out of the 109 therapists that used cognitive therapies to motivate patients, 48 therapists (44%) commented on how this was achieved. The number of emerging themes that were used as the foundation of the thematic analysis during the motivation question was 94. From the therapists’ comments six main categories emerged that explained how cognitive therapies appear to affect stroke patients' motivation The six categories were tasks, goal setting, education of patients, therapies patients can perform themselves, improving psychological states and feedback; see Figure 4.2.

1st order data themes	2nd order data themes	3rd order data themes
Functional tasks	**Tasks**	Increased motivation
Meaningful tasks/Personalisation		
Work to achievable goals	**Goal setting**	
Use short term and long term goals to help patients believe they can progress		
Explain the benefits of the activities on improving motor control and function	**Education of patients**	
Explain that the research suggests cognitive therapies activate the brain		
Therapies patients can perform by themselves	**Patient improvement**	
Progress		
Perform tasks that may aid recovery		
Improve confidence	**Improving psychological states**	
Improve mood		
Positive reinforcement	**Feedback**	
Positive encouragement		
Give positive feedback when activities are achieved		

Figure 4.2. The categories produced during the thematic analysis of how therapists motivate patients through the use of cognitive therapies.

4.3.7.1. Task. Four therapists mentioned the use of functional tasks that are related to ADL and use all the senses help motivate patients: "Use functional tasks such as reaching for cup"; "To think and feel the experience 100% using all senses vision, touch, smell, taste (if appropriate), sound". One therapist mentioned that the tasks that he or she used during action observation were "achievable to encourage positive reinforcement". Twelve therapists mentioned how they made their cognitive therapy sessions personalised to the patient. Personalisation was achieved by allowing patients to visualise during imagery what they needed to improve when performing functional tasks: “… patients can visualise what they need to do and can see how it can be put into functional tasks”. Three therapists linked cognitive therapies to patients’ hobbies and interests. Two therapists got patients to perform “activities they need to perform in future/on discharge”.

One therapist mentioned that cognitive therapies helped to motivate patients by providing “relaxation to reduce anxiety”. Also two therapists mentioned that using positive past experiences during cognitive therapy helped to increase patients’ motivation: “Motivate patient by using positive-experiences during imagery session”. One therapist simply stated that “It's more that engaging in these therapies is motivating for patients”. So giving patients therapies that they could positively engage in keeps patients motivated during their rehabilitation.

4.3.7.2. Goal setting. One therapist set long term and short term goals with the patients to help them believe that they could progress and improve. One therapist stated that the goals that were set were devised between both themselves and the patient, to ensure that they were personalised: “by setting achievable goals (patient specific) maintaining realistic goals and ensuring they’re flexible”. Another therapist also mentioned that his/her patients “always work to achievable goals”. Goals were also written down in the form of a contract by one therapist: “Sometimes create a ‘contract’ with patient”. Writing a contract reminded the patients of what goals they were trying to achieve.

4.3.7.3. Education of patients. Twelve therapists explained to their patients the benefits of the cognitive therapies that they were performing: “by explaining the benefits of the activities in improving their motor control/function”. One therapist gave examples of patients that had been helped by cognitive therapies: “Give examples of how it has helped others”. One therapist also mentioned that one junior physiotherapist working on the ward had a degree in sport science and during his/her studies he/she was taught about the use of imagery in a sporting context. The physiotherapist “produced a leaflet and provided an in-service for the physiotherapy stroke unit”. As mentioned previously in the results, therapists were learning cognitive therapies from their colleagues. Increasing therapists’ knowledge of cognitive therapies allows therapists to explain the benefits of the therapies patients are performing.

4.3.7.4. Patient improvement. Eight therapists had patients perform cognitive therapies without a therapist: “enables patients to do something for themselves or with family to help with their recovery, especially when they have little/no movement”. Patients then felt that they were in control of their recovery: “Patients feel they are helping their recovery and it is something that even severe strokes can achieve independently”. One therapist mentioned that performing cognitive therapies makes “patients feel increase control over their recovery”. When patients are in control of their therapy they feel that they are being “proactive rather than passive” in their recovery; this was mentioned by one therapist. Two therapists said that seeing improvements in movement motivated patients to persevere with the therapy.

4.3.7.5. Improving psychological states. Three therapists commented that when patients’ motivation improved this led to an increase in self-efficacy and mood: “when patients feel that they are helping their recovery their self-efficacy improves”. One therapist increased patients’ confidence by giving verbal encouragement: “Push their confidence by saying such motivational words”. One therapist mentioned that the visual feedback from the mirror box boosted patients' confidence: "As they get a visual feedback we boost up their confidence that they can do it".

4.3.7.6. Feedback. Fifteen therapists said that they gave patients lots of verbal encouragement, positive reinforcement and positive feedback: Three therapists "always stress the positive in any new movements". One therapist commented that by telling patients about the new movements that they can perform, this informs patients about their rehabilitation progress: "feedback/show them results to keep motivation". It was thought by one therapist that "using the techniques encourages them and makes them feel positive about movements/activities which may feel distant or futile to them".

4.3.8. Additional information provided by the therapists. Thirty-seven percent (52/142) of therapists provided additional information about their therapy practice. The number of emerging themes that were used as the foundation of the thematic analysis during the additional information question was 153. The additional information gained from the therapists about the use of cognitive therapies in their current clinical practice formed eight categories. These included ways cognitive therapies are used, inclusion criteria, looking to introduce mirror box therapy, constraints, therapies patients can perform and/or practice by themselves, therapists' views, cognitive therapy experience and cognitive therapy education and knowledge; see Figure 4.3.

1st order data themes	2nd order data themes	3rd order data themes
Therapy	**Ways cognitive therapies were used**	Additional information on cognitive therapies
Imagery therapy		
Mirror box therapy		
Action observation therapy		
Use cognitive therapies for patients with minimal movement who wish to pursue rehabilitation	**Inclusion criteria**	
Use cognitive therapies on only motivated patients with no language impairment		
Trialling mirror box therapy	**Looking to introduce mirror box therapy**	
Planning to use mirror box therapy on the ward as homework		
Time constraints	**Constraints**	
No mirror boxes on the ward		
Cognitive therapies are used to encourage self-practice	**Therapies patients can perform and practice by themselves**	
Therapists think that cognitive therapies are not effective	**Therapists' views**	
Therapists want to use cognitive therapies		
Therapists are interested in cognitive therapies		
Limited use of cognitive therapies	**Cognitive therapy experience**	
Therapists are not sure they are using cognitive therapies correctly		
Therapists have not yet used cognitive therapies		
Therapists know that the therapies are effective from the literature	**Cognitive therapy education and knowledge**	
Therapists are not knowledgeable in the use of cognitive therapies		
Therapists want to know more about cognitive therapies		
Training		
Where the therapies were heard		
Guidance on therapy use is needed		

Figure 4.3. The categories produced during the thematic analysis of additional information provided by the therapists.

4.3.8.1. Ways cognitive therapies were used. Five therapists mentioned that they used functional tasks during imagery and action observation. One therapist had written script protocols for functional activities: “have written script protocols for some activities e.g., walking up stairs, hammering a nail, ironing”. A therapist mentioned that cognitive therapies need to be easy to implement and if this was possible then he/she would be very interested in using them. Another therapist mentioned that “it is useful to have support workers/assistant practitioners who can carry out sessions with the patient away from therapy sessions”. This suggested that this particular therapist was happy for other clinical staff to aid in the delivery of cognitive therapies. Five therapists mentioned that cognitive therapies were delivered during physiotherapy and occupational therapy sessions not as separate sessions: “we try incorporating it during therapy sessions rather than as a separate session”.

During imagery patients were asked to include their own physical feelings. One therapist “spent a bit of time recording reach and grasp activities onto CD so that patients could then hear instructions regarding reaching for their hand feeling the movement, grasping etc, etc”. Also imagery was being used during the early stages of rehabilitation when little or no movement was possible by two therapists. One therapist has found that imagery “works specifically well with walking”. A therapist mentioned that “hands on facilitation is beneficial with some patients when carrying out both imagery and action observation to give additional proprioceptive input I find”. In addition, one therapist mentioned that he/she got patients to look at their unaffected limb for guidance, so that the patient images the affected limb moving in the same way as the unaffected limb.

One therapist mentioned that he/she did not have a mirror box and two therapists rarely used it. Three therapists have only just recently started implementing mirror box therapy and one therapist has "done extensive lit search on mirror box and devised my own method". This shows that even though there were no clinical guidelines on how to use mirror box therapy therapists were determined to implement and devise their own methods. Two therapists commented that they used mirror box with stroke patients that were recovering movement and one occupational therapist got patients to perform imagery every day for 30 minutes during occupational therapy sessions. It was commented by a therapist that he/she used action observation daily and another therapists said "I have always used action observation". A therapist did not feel "that one system is more effective than another; it depends upon each individual patient".

4.3.8.2. Inclusion criteria. One therapist said that he/she used cognitive therapies with severe patients that had little movement: "I use it for clients with minimal movement who wish to pursue rehab activities but have limited functional ability". Patients' motivation level and language ability were used by one therapist to determine whether participants partake in cognitive therapies: "use these techniques only on motivated patients with no language impairment". Patients were excluded from mirror box therapy if they were easily distracted and unable to sustain visual focus.

4.3.8.3. Looking to introduce mirror box therapy. Six therapists were looking to introduce mirror box therapy and one therapist mentioned that he/she wants patients to be able to use a mirror box by themselves in-between therapy sessions: "planning to provide mirror box to use as homework on ward for evenings/weekends - with appropriate patients - who think it could work". One therapist was in the process of trialling mirror box therapy and was looking to introduce it into his/her current clinical practice. One therapist mentioned the importance of implementing mirror box therapy properly and that he/she required advice to do so: “we want to implement it properly and not ad.hoc. Any advice would be gratefully received”.

4.3.8.4. Constraints. Four therapists mentioned that they did not have enough time to implement cognitive therapies: “due to limited occupational therapy resources I don't have time to do mirror therapy with all patients, one occupational therapist for 16 patients”. Availability of mirror boxes has been mentioned as a major delivery constraint by five therapists: “my department does not own a mirror box therefore difficult to implement the evidence base into practice”. A therapist mentioned that he/she was unable to deliver cognitive therapies, as he/she has not received formal training: “I have not seen any courses which we could attend to help us in this process (implement mirror box)”. Three therapists working on hyper-acute wards mentioned that they did not use cognitive therapies but they would like to use them further through the stroke rehabilitation process.

4.3.8.5. Therapies patients can practice by themselves. Three therapists mentioned that patients could practice cognitive therapies by themselves: “generally patients often benefit from an adjunct to therapy they can practice in their own time”. A therapist remarked that he/she used “imagery to encourage self-practice”.

4.3.8.6. Therapists’ views. Three therapists thought that cognitive therapies were not effective and time consuming to produce a positive effect: “takes a long time to get effect, patients find mirror box therapy somewhat frustrating”. One therapist wanted to start implementing cognitive therapies and was very interested in the practical application of mirror box therapy: “I would love to use these techniques and am very interested to its practical application [mirror box]”.

4.3.8.7. Cognitive therapy experience. Three therapists had limited experience in the use of cognitive therapies, which they had picked up during practice: “limited use of mirror box”. Two therapists were worried that they performed cognitive therapies incorrectly, which resulted in them not using the therapies as often as they probably could: “really have no clue if we are doing it right, feel a bit stupid doing it, and therefore don't use it as much as we probably could”. A therapist had heard of cognitive therapies at university but had not used them yet in his/her clinical practice.

4.3.8.8. Cognitive therapy education and knowledge. Six therapists had heard that cognitive therapies were effective from the literature, but two therapists still felt they lacked knowledge about cognitive therapies and wanted to know more: “I have used these (imagery and mirror box) but very rarely due to decreased knowledge”. Five therapists felt that there was a lack of formal training on the use of cognitive therapies during stroke rehabilitation: “I'd love formal training to increase my confidence with using it”. One therapist had attended a workshop that included discussions about cognitive therapies but no specific courses on these techniques. Two therapists had heard about cognitive therapies through personally conducted literature reviews and the internet: “read through research articles and are trying to implement a standard way of using them on a hyper-acute stroke unit”. There was a real sense that therapists would appreciate further guidance on the use of cognitive therapies during stroke rehabilitation. Two therapists were starting to put together their own protocols for mirror box therapy but required further guidance: “we are starting to put together a protocol (mirror box) and would value any advice or suggested reading”.

4.4. Discussion

The aim of the study was to conduct a national skill audit to investigate the extent to which physiotherapists and occupational therapists in the UK use imagery, mirror box therapy and action observation during stroke rehabilitation, to discover how these are conducted and explore therapists' views. The skill audit also aimed to examine how physiotherapists and occupational therapists motivate stroke patients through the use of cognitive therapies. The response rate of the skill audit was 25% (142/564), with the results representing cognitive therapy delivery for a quarter of the stroke units in England, Wales and Northern Ireland. The author was pleased with the response rate, as it can be difficult getting replies to a survey. However, it has been reported by Asch, Jedrziewski, and Christakis (1997) that the average response rate of postal surveys in medical research is 60% and Machin and Campbell (2005) recommend response rates in excess of 70% are desirable. As the response rate was 25% the findings probably cannot be generalised to the entire physiotherapy and occupational therapy population working in stroke rehabilitation. However, they can give an in-depth depiction of how cognitive therapies are being delivered.

Possible reasons for a therapist not replying could be because the survey got lost in the mail, therapists were away when it was sent, the address of the stroke unit had altered or the therapist was too busy and did not want to complete it (Machin & Campbell, 2005). It is also possible that therapists who completed the survey did so because they had an interest in cognitive therapies, through personal experience of administering or because of individual study. If this is the case, it could explain why 97% of therapists had heard of imagery and 68% use imagery in their current clinical practice. The response rate could have been improved by posting reminders to therapists to fill in the skill audit, as research by Millar (2013) found that the combination of sending a postal and email reminder increased the overall response rate by 14%.

Out of the 142 therapists that replied to the skill audit 97% (138) therapists had heard of imagery and mirror box therapy and 60% had heard of action observation. Therapists first learned about imagery and action observation during postgraduate training while mirror box therapy was also learned from colleagues and professional and/or scientific journals. A reason for this may be that mirror box therapy is a more recent therapy technique compared to imagery and action observation. The skill audit was also only sent to the senior members of staff as they dictate the therapies used on the ward. When therapists were receiving undergraduate training and postgraduate training mirror box therapy might not have been on the curriculum resulting in them learning from colleague(s) and through reading current professional or scientific journals.

4.4.1. Cognitive therapy training. Only eleven physiotherapists and six occupational therapists (17/142, 12%) had received training on these therapies. Out of the therapists who had received training, four reported that they had received their training at their place of work. Four therapists mentioned that the workshops they attended were not specifically aimed at instructing them in the use of imagery, mirror box therapy and action observation but were looking more widely at how to improve upper-limb functioning and motivation during stroke rehabilitation. This resulted in cognitive therapies only being mentioned for several minutes on average in such workshops. Without workshops and in house training therapists are not being guided in how to perform these therapies effectively. There are currently no formal guidelines on the frequency and duration of cognitive therapy sessions as well as therapy content.

Clinical guidelines would enable therapy practice to be standardised across the therapist population. Enabling each individual affected by stoke to receive good quality cognitive therapy interventions. Therapists' confidence in their ability to administer imagery, mirror box and action observation should also improve with the aid of clinical guidelines. One therapist mentioned that because of his/her lack of knowledge in the use of cognitive therapies the therapist was unsure that the therapies were administered correctly. Therefore, the therapist did not use cognitive therapies as much as he/she could: "really have no clue if we are doing it right, feel a bit stupid doing it, and therefore don't use it as much as we probably could".

Out of the 42 therapists that reported that they did not use imagery, 30 therapists (71%) would consider with guidance using imagery as a supplement to their physical therapy sessions. Seventy-six therapists reported that they did not use mirror box therapy and 58 of them (76%) would consider with guidance using mirror box during their physical therapy sessions. Also out of the 61 therapists that did not use action observation, 46 (75%) therapists would consider using action observation during physical therapy sessions under guidance. This indicates that if therapists receive greater guidance through workshops, in house training and the development of more detailed therapy guidelines, therapists would be more inclined to administer imagery, mirror box and action observation during stroke rehabilitation.

4.4.2. Factors that influence whether therapists use cognitive therapies. Patients' recovery stage seems to affect therapists' decisions on whether patients should receive cognitive therapies. It was mentioned by six therapists that they work on an acute stroke ward with patients with severe cognitive impairments and that cognitive therapies would not be appropriate during early stages of recovery. However, therapists would like to use cognitive therapies during later stages of recovery: “I work on a hyper-acute stroke unit and many of these therapies are things that I would do further down the line”.

Time constraints appear to be another factor that affect whether therapists use cognitive therapies. Four therapists also mentioned that they did not have enough time to implement cognitive therapies: “due to limited occupational therapy resources I don't have time to do mirror therapy with all patients, one occupational therapist for 16 patients”. Maybe because therapists are not receiving enough support and guidance on how to implement cognitive therapies they are currently spending more time and effort when implementing cognitive therapies than physical therapy. Therefore, therapists are less inclined to use cognitive therapies during physical therapy because of time constraints when working.

How long it takes for a therapy to produce positive effects determined whether therapists used that therapy during stroke rehabilitation. Three therapists did not use cognitive therapies as they thought that these were too time consuming to produce a positive effect: “takes a long time to get effect, patients find mirror box therapy somewhat frustrating”. If therapists were educated in the use of cognitive therapies during stroke rehabilitation so that they understood the potential benefits of these therapies and knew how to implement them effectively, therapists should not find them time consuming, and be more inclined to use them in their clinical practice.

4.4.3. Patient inclusion and exclusion criteria. Imagery, mirror box therapy and action observation were only used on up to 20% of stroke patients. This could be because these therapies might not be appropriate for every stroke patient as a stroke can alter imagery vividness ability and the disability level of the patient. Therapists have mentioned the inclusion criteria they used when deciding whether a patient should partake in cognitive therapies.

Patients' disability level seems to determine whether therapists use cognitive therapies. One therapist said that he/she used cognitive therapies with severe patients that had little movement. This contradicts what therapists who work on acute wards have previously said. Research by Tamir et al., (2007) suggested that imagery can be used during early stages of rehabilitation when little or no movement is available. Therapists do think that cognitive therapies are beneficial during the early stages of rehabilitation. However, they do not use them at this stage because of time constrains, resulting in therapists focusing on life saving treatments. One therapist mentioned that if a patient was not motivated and had language impairments then the participant would not partake in cognitive therapies. This coincided with the meta-analysis results. The meta-analysis found that stroke patients were not being included in imagery studies if patients had aphasia, severe cognitive neglect and severe spasticity. Patients were also excluded from mirror box therapy if they were easily distracted and unable to sustain visual focus, presumably because stroke-affected individuals need to be able to clearly see the reflection of the unaffected limb to provide detailed visual feedback. Therapists did not mention excluding patients from using cognitive therapies based on their age or time post-stroke. This is good as the meta-analysis found no effect of participant age and time post-stroke on the successfulness of imagery.

Patients' imagery vividness also affects whether therapists use cognitive therapies during stroke rehabilitation. Malouin et al. (2008) discovered that individuals affected by stroke find it harder to image the affected side of the body. This could be due to brain reorganisation occurring post-stroke. Carey et al. (2007) reported that on the lesion-free hemisphere of the brain following a stroke there is greater activation of motor-related neural networks. Therefore, as similar neurons are used for imagery, action observation and physical performance (Munzert et al., 2009) reduced motor-related activation resulting in physical impairments following a stroke is likely to reduce imagery vividness of the affected side. The imbalance in motor-related neural networks may decrease as motor function increases but is likely to persist in individuals with severe motor impairments and poor motor recovery (Carmichael et al., 2001). This suggests that imagery vividness could improve in people affected by stroke as movement improves. Interestingly, Ewan et al. (2010b) have also found that individuals affected by stroke experience difficulty when imaging from a first person visual perspective and attempting kinaesthetic imagery when compared to healthy age-matched controls. However, individuals affected by stroke had more vivid third person imagery than controls. This could be a consequence of the lesion damage and functional motor inactivity (Ewan et al., 2010b). Lack of ability to image post-stroke may also be due to a premorbid mannerism unrelated to cerebral damage (Malouin et al., 2008). Therapists need to be able to identify which patients will benefit from these therapies. It would therefore be beneficial to measure patients' imagery ability prior to imagery implementation through the use of the KVIQ, which was specially designed to measure imagery ability in individuals with physical disabilities.

4.4.4. Cognitive therapy use. The skill audit has identified that 68% (91/133) of therapists delivered imagery, 41% (52/128) mirror box therapy and 53% (68/129) action observation. A reason for more therapists using imagery than mirror box therapy and action observation could be because only imagery is in the UK's National Clinical Guideline for Stroke (Intercollegiate Stroke Working Party, 2012). A reason action observation was being performed by therapists more than mirror box therapy could be because the definition of action observation stated in the skill audit was "the observation of movements with the intent to imitate"**.** This meant that patients could observe the therapists during the occupational therapy and physiotherapy sessions and that no equipment was required. It is surprising in that case that action observation was not used by all therapists as it should naturally occur during every therapy session. Therefore, it is possible that not all the therapists understood the action observation definition provided at the beginning of the skill audit.

Mirror box therapy might not be performed by as many therapists as imagery and action observation because it is relatively new and, as such has not been investigated thoroughly enough. Several studies in the mirror box therapy literature, such as Yavuzer et al. (2008), have measured improvements in movement via the mirror box through the use of subjective scales of movement (e.g., Brunnstrom stages of motor recovery). When using scales of movement researchers can introduce their own bias. For example, if researchers have found improvements in Brunnstrom stages of motor recovery through mirror box therapy during previous research, then they will be more inclined to favour higher scores when using the same tool and therapy intervention in the future. When scales of movement are used reliability, checks need to be conducted through the use of at least two assessors to check each other's results. More objective movement tools that could be used are motion capture systems measuring movement kinematics and EMG to measure muscle activation. Movement kinematics has been used by Hewett et al. (2007) to investigate the effect of imagery on motor changes with individuals affected by stroke. However, movement kinematics has not been used to investigate the effect of mirror box therapy on movement. EMG has also been used to measure muscle activation during imagery with stroke-affected individuals (Dickstein, Gazit-Grunwald, Plax, Dunsky, & Marcovitz, 2005), but not during mirror box therapy.

Mirror box therapy may not be performed by as many therapists as imagery and action observation because not all therapists have access to a mirror box. Five therapists mentioned that they did not have a mirror box on their ward, preventing them from using it with their patients: “My department does not own a mirror box therefore difficult to implement the evidence base into practice”. One therapist stated he/she had to share a mirror box with another ward so they were unable to use it with every patient. Therapists have also mentioned that they are not trained in mirror box therapy and there are no departmental or clinical guidelines on its administration. To overcome therapists’ lack of knowledge regarding mirror box therapy, four therapists mentioned that they have conducted their own literature reviews and one therapist is developing his/her own protocol. Six therapists said that they were looking to introduce mirror box therapy for patients to perform during rehabilitation sessions. Also one therapist wanted patients to use mirror box therapy independently “as homework on the ward for evenings and weekends”.

4.4.5. Cognitive therapy delivery. The skill audit has been able to identify whether therapists allow patients to choose the content of cognitive therapies. It is important that therapy sessions are personalised to maintain motivation and engagement. Personalised imagery also produces significantly greater task-relevant muscle activation than experimenter generated imagery scripts (Wilson et al., 2010). This may be beneficial because greater task relevant muscle activation can improve task performance (Hubli & Dietz, 2013). Following improvements in task performance individuals affected by stroke would be able to perform more tasks independently, leading to improvements in motivation (Maclean et al., 2000). Therapists need to make sure that they include patients' views when deciding the content of the therapy sessions. Both occupational therapists and physiotherapists did report that they allowed patients to develop the content of the therapy sessions but not for every cognitive therapy. Physiotherapists did not allow patients to help develop the content of mirror box therapy and action observation while occupational therapists did not allow patients to develop the imagery content. It is unclear why therapists did not always include patients in the development of the therapy content. Maybe occupational therapists enable patients to help develop physical therapy sessions because the role of the therapist is focused on developing strategies to perform tasks while physiotherapists' main focus is on improving movement ability level. Patient disability level can affect the extent to which patients can aid the content of therapies (Playford et al., 2000). Patients with severe disabilities are often ashamed of their disability or modest in their attempts to suggest appropriate tasks to perform during rehabilitation. Therefore, therapists devise the content of the therapy sessions without the input of the patients (Playford et al., 2000).

The skill audit has identified that there are differences in the delivery of the cognitive therapies. Imagery and mirror box are delivered by both the therapist and the patient but action observation is solely delivered by the therapist. Through the use of video recordings it would be straightforward for therapists to conduct action observation without a therapist, especially as it is now easier than ever to produce good quality video recordings in the first person visual perspective, with the aid of newly developed recording and editing equipment (Holmes, 2011).

4.4.5.1. Cognitive therapy frequency and duration. It is important for therapists to be guided on the most effective duration and frequency of imagery, mirror box therapy and action observation sessions. At present, this information is not included in the National Clinical Guideline for Stroke (Intercollegiate Stroke Working Party, 2012). In the literature, the duration of imagery, mirror box and action observation interventions vary greatly.

In their systematic literature review on the use of imagery in medicine, Schuster et al. (2011) found that interventions leading to the greatest improvements in movement ability on average lasted 34 days, involving practicing three times per week for 17 minutes, with 34 imagery trials. Comparing the research findings with the skill audit results shows that therapists are not getting patients to perform imagery often enough to effectively improve movement ability, as patients are most often only performing imagery once a week.

In the literature mirror box therapy is being performed on average longer than imagery. On average mirror box is performed for 30 minutes 5 times a week (Sütbeyaz et al., 2007; Yavuzer et al., 2008). This indicates that therapists should use mirror box at a higher frequency, for example 5 times a week, instead of once a week. Performing mirror box therapy only once a week could slow down the rehabilitation process, which could lead to increased frustration and demotivation.

Grünert-Plüss, Hufschmid, Santschi, and Grünert (2008) have devised a mirror box protocol based on the literature. The protocol is called the St Gallen protocol for mirror therapy and the authors recommended that it should be performed 5-6 times per day for no longer than 5-10 minutes. Mirror box therapy should be performed for short durations of time so that patients do not become tired or bored. Nevertheless, 5-6 times a day is unrealistic as this could prevent patients from partaking in other forms of rehabilitation such as speech and language therapy. In addition, patients' motivation might decrease if the therapy becomes a chore resulting from the high frequency use.

The frequency and duration of physiotherapists' action observation sessions are in accordance with what the literature has found to be effective (Ewan et al., 2010a; Franceschini et al., 2010). The majority of physiotherapists are performing action observation for 31-40 minutes, more than 3 times a week. However, occupational therapists are only performing action observation once a week for up to 10 minutes. It is unclear why occupational therapists perform action observation for a shorter duration and less frequently than physiotherapists. A reason for this could be that occupational therapists are unsure that they are using this technique correctly, so when they do use it they decide to only try it for a few minutes. This is supported by the results of the skill audit. Two therapists mentioned when they completed the skill audit that they were unsure if they used cognitive therapies correctly: "I really have no clue if we are doing it right, feel a bit stupid doing it, and therefore don't use it as much as we probably could".

4.4.5.2. Comparisons between cognitive therapy delivery. Differences were found between the delivery of imagery, mirror box therapy and action observation. More action observation sessions are performed during an average week than imagery and mirror box therapy. Action observation was performed more than three times a week while imagery and mirror box therapy were performed only once a week. This could be because therapists might find it easier to incorporate action observation into every physical therapy session as therapists always need to demonstrate movements (Talvitie & Reunanen, 2002). This also explains why action observation sessions are longer than imagery and mirror box therapy as action observation can occur during most of the therapy session. However, therapists would have to always use a mirror box to partake in mirror box therapy and imagery does not occur when therapists are demonstrating movements, it occurs afterwards. Therapists combined cognitive therapies together. The most popular combination of cognitive therapies, by therapists, is imagery and action observation (31/109, 28%). This could be because both imagery and action observation do not require any equipment. The skill audit identified that not all therapists have access to a mirror box: “My department does not own a mirror box therefore difficult to implement the evidence base into practice”. Therefore, without a mirror box therapists were unable to implement mirror box therapy. In research by Liu et al. (2004a) task analysis occurred prior to the imagery intervention so that participants could view movement mistakes. Participants were then told how to improve their performance so that the imagery could focus on the specific aspects of movement that needed to be improved. Action observation therefore occurred during task analysis when participants watched their performance.

Mirror box therapy is commonly used with imagery (17/109, 16%), action observation (7/109, 6%) or both (24/109, 22%) than by itself (4/109, 4%). This suggests that therapists are recognising that each therapy has its own benefits. For example, imagery does not require any visual stimulus from a mirror or observing other individuals. Nevertheless, the physical performance that occurs during mirror box therapy can provide imagery and action observation with increased information regarding the feel and form of the movement (Ramachandran & Altschuler, 2009). Therefore, imagery, mirror box and action observation could potentially be more beneficial when performed together. Therapists have recognised the potential of combining the therapies together as imagery, mirror box therapy and action observation are being used in the same therapy sessions.

4.4.6. Cognitive therapy content. Five therapists mentioned that cognitive therapies were included during physiotherapy and occupational therapy, not as separate therapy sessions. This is suitable as combining imagery, mirror box therapy and action observation with physical performance will increase imagery vividness and kinaesthetic awareness (Page et al., 2005). Imagery has been found to be more effective at improving physical ability post-stroke when combined with physical practice (Liu et al., 2004a) than without physical practice (Ietswaart et al., 2011). This may be because the physical performance of the task will be fresh in the patient's mind; what the movement felt like, which muscles were contracting and what was seen when performing the task (Braun, Kleynen, Schols, Beurskens, & Wade, 2008). Therefore, this could potentially lead to greater levels of muscle activation in the task-relevant muscles, resulting in greater movement ability (Hubli & Dietz, 2013). However, more research is needed to determine whether imagery performed during physical therapy increases muscle activation during imagery, compared to imagery that is performed without physical therapy.

The content of the therapy sessions is very important. Imagery that focuses on the kinaesthetsis of movements has been found in healthy individuals to increase physical performance and task-relevant muscle activation (Ranganathan, Siemionow, Liu, Sahgal, & Yue, 2004). Kinaesthetic imagery focuses on the feel of the movement that is imaged and which muscles were active during physical movement (Dickstein & Deutsch, 2007). Task-relevant muscle activation has also been reported during the performance of personalised imagery in healthy individuals (Wilson et al., 2010). To enable limbs to move, the muscles supporting the limbs need to be stimulated (Saladin, 2004). By including individual kinaesthetic responses during imagery greater physiological responses could occur. This could result in increased muscle activation (Bakker, Boschker, & Chung, 1996) leading to increases in strength (Narici, Roi, Landoni, Minetti, & Cerretelli, 1989). More research is needed to ascertain whether individual kinaesthetic responses during imagery would also be beneficial in a stroke rehabilitation setting. Individual kinaesthetic imagery might facilitate physical practice to enable patients to move their affected limbs and manipulate objects more effectively. Therefore, it was pleasing to discover that therapists reported in the skill audit that they have patients emphasise the physical movements performed during the therapy session when performing imagery. Therapists have also reported that they discover patients' hobbies and interests, so that they can be included during cognitive therapy sessions.

Patients also visualise past and present experiences but not future aspirations. It is unexpected that therapists did not get patients to do this. This is because it would be beneficial for the muscles that need to be active during aspired movements to become stimulated during imagery sessions. Performing future aspirational activities are also beneficial as it aids in the generation of patient-centered goals that will lead to an increase in motivation (Leach et al., 2010). It is important to have written instructions containing information about what the patient should be imaging so that patients can perform the imagery by themselves and to monitor the content of the therapy sessions. The therapists did not produce an imagery script and it is unknown whether they produce any instructions. Therapists also asked patients to image from a first person visual perspective. A first person visual perspective is beneficial when trying to produce kinaesthesis of the movement, but a third person visual perspective is also beneficial when attempting to enhance the form of the movement (Fery, 2003). Therefore, research into optimal imagery content during clinical rehabilitation settings, such as post-stroke, needs to be investigated.

The content of mirror box therapy was also based upon present activities which is the same as imagery. Future aspirational activities might not be included during mirror box therapy, as patients have to physically perform tasks with their affected limb behind the mirror. Therefore, therapists might not want patients to over-exert themselves, by trying to perform future aspirational activities, to prevent patients from hurting themselves. Also, even though patients will not be able to observe themselves not performing the movement correctly, because of the mirror reflecting the unaffected limb, they might still be able to feel that they cannot perform the task correctly. This could result in patients becoming frustrated and reduce motivation.

Out of the 52 therapists that used mirror box therapy only five therapists (9.6%) used flash cards at the start of every mirror box therapy session. Flash cards teach patients the distinction between left and right sides of the body, and only three occupational therapists used flash cards until patients could make this distinction. The brain damage following a stroke can inhibit individuals from being able to determine between their left and right side of the body (Bowering et al., 2013). Individuals need to be able to determine between their left and right when performing mirror box therapy. This is because patients need to be able to understand that the reflection of their unaffected arm in the mirror is giving the illusion that it is their affected arm. Therefore, patients need to be able to identify that the reflection, for example of the unaffected right hand, looks like the affected left hand. Priganc and Stralka (2011) suggested that until patients can accurately distinguish between their left and right side of the body it is counterproductive to progress with cortical retraining activities. It is surprising that flash cards are not used by more therapists, as they are commonly used to measure imagery ability during image rotation tasks of different limbs.

Out of the 52 therapists that reported that they did mirror box therapy, only 14 therapists (27%) had patients image themselves moving their hand into positions that they might find uncomfortable. A mirror box was first used by Ramachandran (1994) in the treatment of phantom limb pain after amputation. Ramachandran had patients move their unaffected arm into a position of discomfort and then slowly relax, while looking at the reflexion in the mirror. The relaxation of the unaffected arm reduced the phantom limb pain. It is possible that mirror box therapy could be used to reduce limb pain post-stroke, but more research is needed to determine whether this is so. Therefore, therapists are currently focusing on using mirror box therapy to improve movement.

Therapists also mentioned that they did not use resistance aids during mirror box therapy sessions to aid in the increase of muscle strength. Resistance aids such as resistance bands and resistance balls are used regularly during physical therapy sessions to increase muscle strength (Ouellette et al., 2004). However, no research has been conducted to investigate whether resistance aids provide an additional benefit during mirror box therapy. Mirror box therapy with resistance aids could potentially increase muscle strength as well as range of movement. Increased muscle strength would facilitate patients in grasping, picking up and moving objects, therefore enabling people affected by stroke to feed and drink themselves, allowing them to be less dependent on carers.

The content of action observation was also based upon present activities, as with imagery and mirror box therapy. Action observation would also be a prime opportunity to observe future aspirational activities. This is because physical movement is not required during action observation so tasks that were currently too difficult for the patient to perform could be observed. This would help reactivate the neurons required for the aspired movement helping to reengage patients in movements that may have seemed distant and futile (Ewan et al., 2010a). Action observation should also be personalised to the patient, as personalised action observation has been found to improve TUG and increase confidence (Chatterton et al., 2008). During action observation patients are asked to image from a first person visual perspective. Research by Celnik et al. (2008) has found that motor memory formation was greater with a combination of physical therapy and congruent action observation (performed and imaged actions in the same direction), than physical therapy alone, or physical therapy and incongruent action observation (performed and imaged actions approximately in opposite directions). This indicates that during action observation interventions observed actions should be in the same orientation and direction as physical performance, to enhance motor training after stroke. Therefore, therapists are correctly getting patients to observe actions in the same direction and orientation as physical performance by images being in the first person perspective. However, therapists need to take into consideration the visual preference of the patient. The visual perspective that the patient finds the easiest to observe should be adopted during action observation sessions.

4.4.7. Motivating patients during stroke rehabilitation. A lack of motivation is one of the key factors associated with stroke (Maclean et al., 2000). When individuals are demotivated to take part in rehabilitation they will put less effort (Sage, 1977) into rehabilitation resulting in slower progression. When progression is slow patients might become increasingly frustrated (Maclean et al., 2002). Patients might also not adhere to rehabilitation programmes. Therapists reported that they did use imagery, mirror box and action observation to motivate patients.

4.4.7.1. Therapy tasks. Determining which tasks to include in therapy sessions is very important. Therapists used personalised tasks that were functional and related to ADL. This is in accordance with the literature which has found that imagery (Page et al., 2001a), Mirror box therapy (Yavuzer et al., 2008) and action observation (Ertelt et al., 2007) that included functional tasks improved movement ability. Patients' motivation levels then increase when they see improvements in performance (Lloyd, 2012). This results in patients applying even more effort leading to further improvements. Patients are also more likely to engage in therapy sessions when they are performing personalised tasks that they want to improve (Lloyd, 2012).

4.4.7.2. Goal setting. Goal setting is a key technique used to improve motivation. Research by Maclean et al. (2002) found that more than half of professionals thought that setting relevant goals has a positive effect on motivation; this coincides with the finding of this study. Therapists reported that they set both long-term and short-term goals to help patients believe that they can progress and improve. Therapists are setting realistic goals. If goals require little or no effort to achieve patients lose interest (Deci & Ryan, 1985). However, if goals are too difficult then this leads to patients becoming frustrated and experience decreased confidence (Deci & Ryan, 1985). It is very important to find a balance between challenging goals and achievability (Voight, 2006). Therapists need to make sure that the goals are challenging enough to facilitate improvements in movement but not so difficult that they are unachievable.

Limited information was provided by the therapists regarding the development of the goals and what they focused on. Two therapists mentioned that the goals were set by the patient. No other therapists detailed whether the goals were solely set by the therapist or also guided by the patient. As previously mentioned in section 2.15.2.3 of the literature review, patients' level of severity can affect how much they contribute to the development of goals. A therapist-led approach is adopted when patients have communication problems (Playford et al., 2000). Patients with greater cognitive and movement ability have been reported by Leach et al. (2010) to contribute more in the development process of goal setting.

Therapists also did not mention whether the goals were outcome (focuses on a result e.g., being able to lift up a cup) or task (focuses on the actions of an individual when performing a task e.g., full arm extension when reaching for a cup) orientated. It has been suggested by Siegert and Taylor (2004), that goals that are task orientated protect patients from becoming disappointed, frustrated and decreased motivation when others are recovering at a faster rate. Task orientated goals increase motivation by providing individuals with greater control over goal accomplishment resulting in them persisting longer when failure is close (Preissner, 2010). Therefore, to improve motivation during rehabilitation goals should be task orientated, based on the assessment of ability, be decided with the involvement of patients and family and implemented after patients and family have been educated.

4.4.7.3. Education of patients. Following goal generation it is important that therapists educate patients and family about what they hope to achieve through rehabilitation, what they could expect along the path of rehabilitation and how they could be reintegrated into society when they have left hospital (Leach et al., 2010).

Education during rehabilitation has been found by McAndrew et al. (1999) to significantly increase the effectiveness of the collaboration between the patient and therapist, which is fundamental to the setting of realistic and achievable goals. If patients are not educated about the goal setting and rehabilitation process decreased motivation may occur when patients are trying to achieve outcomes (Hafsteinsdottir & Grypdonck, 1997). Therapists did not mention whether the patient and family members are educated on the goal setting process. If patients and family members are not educated about these issues, the patients could experience decreased motivation. However, the therapists did explain the benefits of the cognitive therapies that patients are performing. This educates patients so that they know why they are performing cognitive therapies during their rehabilitation sessions. Patients will therefore be encouraged to work hard during therapy sessions because they will understand that cognitive therapies can aid recovery.

4.4.7.4. Attribution of patient improvement. None of the therapists mentioned that they allowed the patients to perform cognitive therapies by themselves even though cognitive therapies can be performed without a therapist. One therapist mentioned that he/she are planning to provide patients with mirror boxes which they can then use by themselves, as homework, on the ward. Allowing patients to perform cognitive therapies by themselves will enable patients to feel that they are helping and are in control of their recovery. According to attribution theory (Weiner, 1985), if patients attribute improvements in performance during rehabilitation to factors that are within their control, motivation levels should increase. Patients will feel in control of their rehabilitation if they are allowed to decide the content of cognitive therapies and goals as well as performing therapies without the therapist. When patients think they are helping their recovery, this will also increases their self-efficacy and mood (Vealey et al., 1998). Patients then become more confident to try new tasks and set challenging goals.

4.4.7.5. Feedback. Patients need to receive feedback to know how recovery is progressing and to determine whether specified goals are being achieved. Therapists reported that they give a large amount of verbal encouragement, positive reinforcement and positive feedback, which allows patients to know when they have achieved goals. Maclean et al. (2002) found that older patients respond less positively to encouragement because they are older they "have less to live for" (p.447). A therapist stated that "if a 75year old was to reject therapy I would be more willing not to push" (Maclean et al., 2002, p.447). Therapists provided more encouragement to younger patients as they have more time ahead of them. Maclean et al. (2002) also found that therapists deem motivation to be affected largely by a patient's personality thus resulting in therapists classifying patients as motivated or unmotivated. Therapists then gave limited verbal encouragement to patients that had been classified as being unmotivated. Therapists in this study did not mention differences in encouragement depending on the age of the patient. Maybe this is because cognitive therapies can be used at any age and can help engage patients in rehabilitation, giving patients greater hope for the future. Therapists also did not mention that they classified patients as being motivated or demotivated. This could be because therapists have been informed about the negatives of this practice or they did not want to mention that they adopt this practice.

4.4.8. Study limitations. The skill audits were not marked to enable the identification of which area of the country the reply had come from. This would have allowed comparisons to be made between therapy use and delivery between geographical areas. There is a lack of statistical comparison between therapists to compare cognitive therapy techniques. However, after viewing the data following its analysis, there did not seem to be enough differences to warrant statistical comparisons to be made. Physiotherapists and occupational therapists views during the qualitative analysis were also not separated. Therefore, it is unknown whether motivation techniques used during stroke rehabilitation differ between professions.

4.4.9. Conclusion. The skill audit shows that therapists are implementing cognitive therapies and understand the benefits of using them, but require more training on how to deliver them to increase their effectiveness. Clinical guidelines are required to standardise the delivery of imagery, mirror box therapy and action observation during stroke rehabilitation. However, more research in this area is required to enable the production of detailed clinical guidelines.

Therapists have reported that they do use cognitive therapies to improve motivation, as well as techniques that have been thoroughly documented in the sport literature, such as goal setting, task specificity and feedback. Therefore, therapists are implementing cognitive therapies during stroke rehabilitation to improve patients' movement and motivation.

Chapter Five: General Discussion

5.1. Summary of findings

The imagery meta-analysis revealed a treatment effect of 0.48 when imagery was used during stroke rehabilitation to improve movement ability. The moderate treatment effect occurred because there was a large variation in study results caused by a large variation in study design and imagery content. Dependent variables used to measure increases in movement ability varied greatly. Studies examining gait found greater improvements following imagery compared with scales of movement that measured the upper extremities, which produced low effect sizes (e.g., Ietswaart et al., 2011). None of the imagery interventions performed in the literature were individually tailored to the participants' needs. Interestingly, this individual tailoring has been shown to increase muscle activation (Wilson et al., 2010) so may help activate the target muscles in stroke patients, though this requires empirical investigation. Clinical guidelines are needed for therapists to deliver effective imagery.

Therapists also commented when completing the skill audit that they required more guidance on how to implement cognitive therapies during stroke rehabilitation as they are unsure whether they are administering the therapies correctly. The skill audit shows that therapists are implementing cognitive therapies and understand the benefits of using them. Clinical guidelines are required to standardise the delivery of imagery, mirror box therapy and action observation during stroke rehabilitation, but more research in this area is required to enable the production of detailed clinical guidelines. Therapists have reported that they did use cognitive therapies to improve motivation, as well as techniques such as goal setting, task specificity and feedback.

5.2 Limitations of the thesis

A stroke affects everyone differently, so the use of cognitive therapies will not be appropriate for every stroke patient. A stroke can affect individuals' cognition and concentration (Stroke Association, 2015), resulting in them being unable to focus on watching movements during action observation for any substantial length of time. Damaged brain cells during a stroke can prevent individuals from moving their limbs, which can also reduce imagery ability (Hochstenbach & Mulder, 1999). Imagery will not be appropriate if the patient is unable to vividly image movements. Mirror box therapy will also not be suitably for individuals with impaired vision, as they will not be able to clearly see the reflection of the unaffected arm in the mirror, preventing them from receiving visual feedback when sensory feedback is not possible. According to SSNAP (Royal College of Physicians, 2013), mirror box therapy is potentially not suitable for 60% of the stroke population as that is the percentage of individuals who have visual problems following a stroke. These reasons could explain why therapists use imagery, mirror box therapy and action observation with 1-20% of their patients. However, as individuals affected by stroke recover they may be able to benefit from cognitive therapies when performed by community-based therapists or independently, when therapy has stopped.

There were several limitations to the thesis, which will be discussed below. A limitation is that four studies could not be included in the meta-analysis because they did not present means and standard deviations and 15 studies had less than five participants in each group. It was frustrating when a study had to be rejected from the analysis as it reduced the number of studies that could be included. The searching process during the meta-analysis was very thorough, but it is inevitable for studies to be missed. Two studies did not provide detailed information regarding image perspective (Verma et al., 2011; Boverd'Eerdt et al., 2010), resulting in them not being included in the additional meta-analyses. Two studies also had to be removed from the multiple linear regression because they did not include the duration of imagery therapy sessions (Dijkerman et al., 2004) or time since stroke (Lee et al., 2011). When few studies are included in the analysis, the results cannot be generalised to the whole stroke population.

Only two studies used in the meta-analysis included more than 30 participants, Liu et al., (2004a) included 46 participants and Ietswaart et al., (2011) 121. Few RCT are conducted because they are costly to perform, time consuming and require several hospitals to participate in the research. When inclusion and exclusion criteria for a study are very specific then it is harder to recruit participants. Also the findings only reflect a small sample of the stroke population who, for example, are between the ages of 60-80, have sustained a stroke at least 6 months prior the participation in the study, are not receiving physical therapy, use a wheelchair, have psychological or communication problems (Dickstein et al., 2013).

Limitations of the skill audit study are that the addresses were unable to be obtained for stroke units in Scotland. This was disappointing as Scotland has the highest percentage of the population who are stroke survivors in the UK (2.16%; Stroke Association, 2015). It is recommended that further research be conducted into the use of cognitive therapies in Scotland.

Another limitation of the skill audit study is that not all therapists completed every question as they did not all use imagery, mirror box therapy and action observation during stroke rehabilitation, which reduced the number of responses. It was also disappointing when therapists did not complete the open-ended questions or only replied with a single sentence, reducing the breadth and depth of the data. In the future, to gain more in-depth information about cognitive therapy delivery, interviews should be conducted. Unfortunately, due to the poor response rate (25%) the skill audit data may not be generalizable to the whole stroke therapy population. To increase the amount of responses, the skill audit could have been sent electronically as well as in a hard copy format. Online surveys can prompt individuals to complete missing data fields and can automatically analyse the data as soon as it has been completed. Sending reminders could also help increase response rates.

Even though there are limitations to the thesis both studies have been able to inform the formation of clinical guidelines for cognitive therapy delivery and provide advice on the design of future studies on the use of imagery, mirror box therapy and action observation during stroke rehabilitation. Cognitive therapies might not be appropriate for everyone following a stroke, but patients on the ward or at home could use them independently, to reengage in activities and enable them to take control of their own therapy. Cognitive therapies can easily be adapted to accommodate the different difficulties individuals are experiencing following a stroke. For example, patients who struggle with fatigue could perform short duration of cognitive therapy sessions, so not to over exert themselves. Activities performed can be personalised to individuals' past experiences, present activities and future aspirations, therefore, making therapy sessions interesting, relevant to patients' goals and help improve motivation.

5.3. Clinical guidelines for therapists on cognitive therapy delivery during stroke rehabilitation

Information from the literature and the results from the skill audit can help inform clinical guidelines on the use of imagery, mirror box therapy and action observation during stroke rehabilitation. The clinical guidelines should include information regarding participant inclusion and exclusion criteria, therapy delivery and content and how to motivate patients.

When considering cognitive therapy inclusion and exclusion criteria therapists should perform cognitive therapies with chronic stroke patients as well as acute patients. The meta-analysis has highlighted that imagery can significantly improve patients' movement even if they have sustained a stroke 42 months (Page et al., 2007) prior to participating in imagery therapy. The multiple linear regression performed during study one found that the age of the patient and time post-stroke did not affect the effectiveness of imagery. Study one also helped identify commonly used participant inclusion and exclusion criteria used by researchers investigating imagery post-stroke. Participants were commonly not included if they had aphasia and severe cognitive neglect. Reasons for this could be because when patients have difficulty speaking it is more difficult for therapists to monitor what the patient is imaging. In addition, therapists would be unable to personalise the imagery to the patients' interests and aspirations as response training would be difficult with aphasia patients. Personalisation of imagery has been shown to be beneficial, as it increases task relevant muscle activation (Wilson et al., 2010). Personalised action observation has also been found to improve TUG performance and increase the participant's confidence to progress to attempting to walk without a cane (Chatterton et al., 2008). However, the findings of the meta-analysis in study one suggest that with most stroke-affected individuals imagery could be beneficial. Therefore, cognitive therapies could be offered to most patients.

The skill audit also obtained information from therapists regarding cognitive therapy inclusion criteria. One therapist mentioned that he/she used cognitive therapies on patients with minimal movement who wanted to pursue rehabilitation. Patients were excluded from mirror box therapy if they were easily distracted and unable to maintain visual focus. If patients were unable to focus on the mirror reflection of the unaffected-limb they would not receive visual feedback to activate the hMNS. Nevertheless, patients with visual problems could still attempt mirror box therapy as movement benefits might occur from the physical practice. Patients might also be motivated to perform mirror box therapy as they cannot see their affected-limb (Maclean et al., 2002). Therapists could therefore use cognitive therapies on patients with minimal movement, of any age, at any stage of recovery and with visual impairments.

A patient inclusion criterion that therapists should consider when implementing imagery during stroke rehabilitation is patients' imagery ability. This is because the lesion following a stroke can lead to a deficit in motor execution, which can affect imagery ability, as similar neurons are used during motor execution and imagery (Munzert & Zentgraf 2009). Research by Mulder (2007) has also identified that individuals who are less physically active have lower imagery ability. The results of the meta-analysis identified that studies by Page et al. (2001) and Hwang et al. (2010) screened participants' imagery ability prior to participation. Participants had to score greater than 25 (Page et al., 2001) or 32 (Hwang et al., 2010) on the Movement Imagery Questionnaire Revised (MIQ-R; Hall & Martin, 1997) to be included in the study. The MIQ-R has been used extensively in imagery research that uses sporting populations, but it has not been validated when used with stroke-affected individuals. However, the KVIQ has been validated by Malouin et al. (2007) with individuals affected by stroke. Therefore, it would be beneficial for therapists to assess patients' imagery clarity and sensitivity intensity with the KVIQ prior to conducting imagery. Imagery ability can improve post-stroke (de Vries et al., 2011), therefore, therapists could reassess patients who initially had poor imagery ability, later in the rehabilitation process.

In the literature, recommendations on cognitive therapy delivery have been made by several researchers. Imagery interventions have produced positive results for improving movement when imagery was implemented for 17 minutes three times per week (Schuster et al., 2011). Mirror box therapy has been found to improve movement when performed for 30 minutes 5 times a week (Sütbeyaz et al., 2007; Yavuzer et al., 2008). The results of the skill audit have identified that therapists should probably perform imagery and mirror box therapy more frequently then they currently do, which is once a week. Action observation has been reported to improve movement when performed 31-40 minutes, more than 3 times a week (Ewan et al., 2010a; Franceschini et al., 2010). Physiotherapists are currently performing action observation at the same intensity and duration as reported in the literature, but occupational therapists could perform action observation for a longer duration.

It is advisable that cognitive therapies are incorporated during physiotherapy and occupational therapy sessions, not as separate therapy sessions. The results of the meta-analysis showed that when imagery was performed straight before (1.03) or after (0.68) physical therapy a moderate to large mean treatment effect was produced. However, when imagery was performed without (-0.01) physical therapy no meaningful treatment effect was produced. In the skill audit several therapists mentioned that they allow patients to perform cognitive therapies independently to give patients more control over their rehabilitation and increase motivation. Therapists should allow patients to perform cognitive therapies independently in-between therapy sessions.

To enable patients to remain interested during cognitive therapy sessions, therapists mentioned in the skill audit that both the therapists and the patient decided the content of the therapy. During cognitive therapy sessions, therapists also included personalised functional ADL focusing on activities patients could currently perform and future aspirational activities. Therapists are engaging patients in activities they want to be able to perform, helping to increase their motivation. The results of the meta-analysis found that imagery seems to be more effective in improving upper-limb ADL. When patients want to improve lower-limb activities then imagery should be used more intensively and combined with action observation and mirror box therapy to enhance recovery.

Improvements in movement have been found when performing imagery in the first person visual perspective (Page et al., 2005; 2007) and the third person visual perspective (Page, 2000; Page et al., 2001a). However, the results of the meta-analysis indicate that greater improvements in physical function occur when imagery is performed from a third person perspective. People affected by stroke also sometimes experience more difficulty when performing imagery from a first person visual perspective (Ewan et al., 2010b). Therefore, it would be beneficial if imagery was performed from a third person visual perspective. Prior to implementing imagery it would be advisable for therapists to check whether the patient has a personal preference to which imagery perspective they would like to use. The imagery perspective that the patient prefers should then be used during imagery.

Another factor that could improve the effectiveness of imagery is the inclusion of task sequencing analysis. The results of the meta-analysis indicated a high treatment effect of imagery on improving patients' movement post-stroke when task sequencing analysis was included during imagery interventions (Liu et al., 2004a). The task sequencing analysis facilitated motor planning and problem identification and action observation also occurred as patients had to observe a video recording of their performance. Action observation, from a first person perspective, could provide detailed information on the kinaesthesis of the movement being imaged. During the study by Liu et al. (2004a) therapists also informed patients on how to rectify their own movement problems, therefore enabling the imagery to be personalised to the patients' individual needs. Cognitive therapies should therefore be personalised and inform patients how to correct any movement problems.

During action observation, observed actions should be in the same direction as physical performance, to enhance motor training after stroke (Celnik et al., 2008). Observing actions in orientations that are not physically possible to perform has been found to not improve physical performance of the observed task (Celnik et al., 2008). During imagery, mirror box therapy and action observation therapists need to advise patients to focus on the form and feel of the movement, thus providing large amounts of sensory information. The sensory information during cognitive therapies helps to improve movement coordination and strengthen neural networks (Mulder, 2007). Therapists mentioned in the skill audit that they did not write imagery scripts when implementing imagery. However, by therapists producing imagery scripts or audio tapes of imagery interventions and DVD recordings of action observation, patients could perform imagery and action observation by themselves and the content of the therapy sessions can be monitored.

Whether patients can distinguish between left and right limbs will determine whether flash cards are used during mirror box therapy. The skill audit identified that only eight therapists used flash cards straight before mirror box therapy. However, the use of flash cards before mirror box therapy can help retrain patients to identify which limbs are from the right or left side of their body (Moseley, 2004). This enables patients to identify that the reflection in the mirror looks like their affected limb is moving. Resistance aids could also be used during mirror box therapy to improve patients' strength. Therapists have reported in the skill audit that they are combining cognitive therapies during therapy sessions. The most common combination was imagery and action observation (31/109, 28%). Twenty-two percent (24/109) of therapists used all three cognitive therapies during stroke rehabilitation. It would be beneficial to use imagery, mirror box therapy and action observation during the same therapy session, as the physical performance that occurs during mirror box therapy could provide imagery and action observation with increased information regarding the feel and the form of the movement.

Patients' levels of motivation could affect how well they engage during stroke rehabilitation (Maclean et al., 2000). Therapists reported in the skill audit that they did use imagery, mirror box therapy and action observation to motivate patients. Therapists motivated their patients by imaging, observing and performing personalised and functional ADL. Therapists set both long term and short term goals that were realistic. The short term goals enabled patients to focus on tasks that they could accomplish in a short amount of time. The short term goals also helped patients get closer to achieving their long term goals. By therapists setting both short and long term goals, patients will be able to focus on the cognitive therapy tasks they need to perform to fulfil their goals (Emmons, 1996). One therapist mentioned that he/she devised a contract which stated the goals that both the therapist and patient had devised together. Writing down the goals that have been devised enables both the patient and the therapist to know what goals have been agreed. This will allow therapists to monitor if the goals have been completed. Patients would also be aware of the goals that they are striving to achieve.

Therapists told patients when goals had been completed and provided verbal encouragement and feedback on how to improve performance. By therapists emphasising which aspects of movement needed to be improved when providing feedback, patients would be able to focus on imaging their movement weaknesses correctly. In addition, when therapists provide physical demonstrations (action observation) during therapy sessions, therapists could emphasise how patients need to correct their movements. By observing others and imaging themselves performing movements correctly, patients might believe that their physical movement can improve. When therapists tell patients that they are improving, patients might be more encouraged to adhere to, and work harder during, rehabilitation sessions (Maclean, 2000). Therapists also mentioned that they educated patients and family members about the mechanisms that cause cognitive therapies to improve movement. This allowed patients to learn why they perform cognitive therapies during rehabilitation. Therefore, during therapy sessions therapists need to provide verbal encouragement and feedback, explaining how cognitive therapies will help patients' recovery and set realistic short and long term task-orientated goals to help motivate patients.

5.4. Guidance for further research conducted in the use of imagery, mirror box therapy and action observation during stroke rehabilitation

In addition to guidance for therapists when implementing imagery, mirror box therapy and action observation, guidance is also needed for researchers conducting research in this interesting area. When conducting the meta-analysis some studies had to be excluded because they did not include means and standard deviations to calculate effect sizes. The majority of authors also did not provide detailed descriptions of the design of the study and the content of imagery interventions. Other studies were excluded because the methodology used was not of sufficient quality according to the AMCL. By following the AMCL criteria, the methodological quality of the study should increase. Below is a list of suggestions that should be considered when developing study designs and when writing research on cognitive therapies in stroke rehabilitation.

Study design guidance according to the AMCL:

- There should be a control group to correct for attention.
- Participants should be randomly assigned to a group.
- The group allocation of participants should be concealed to researchers.
- Baseline results for all groups should be similar.
- The demographic of participants (e.g., age, time since stroke and severity of stroke) between groups should be similar.

- Experimenters need to check that participants are complying with the intervention through telephone calls, questionnaires and/or rehabilitation diaries.
- Low withdrawal rates from the study (e.g., less than 10% [AMCL])
- Relevant outcome measures to be used to accurately record changes in the dependent variable being investigated.
- Testing to occur pre- and post-intervention with any follow up periods being conducted no shorter than 3 months post-intervention.

Guidance for study write up:

- The inclusion of mean and standard deviation data for every dependant variable investigated.
- Include information regarding which image perspective was used during imagery and action observation.
- Include any written imagery scripts or a detailed account of the activities participants were asked to image or observe.
- Mention whether the therapy session included physical practice and if so when the cognitive therapies were performed in relation to physical practice.
- Include details regarding the types of physical activities performed during therapy and testing.

- Include a detailed account of how long therapy sessions lasted, frequency of session and how long the intervention lasted for.

- Include a detailed account of lesion location according to the OCSP Classification.

5.5. Further research

The skill audit highlighted that clinicians require more guidance in the implementation of cognitive therapies. To enable detailed guidelines to be produced to aid therapists in cognitive therapy administration, more research is needed examining cognitive therapy delivery and content. It is unknown whether the environment that cognitive therapies are delivered in alters their effectiveness. In the sport psychology literature it has been found that this is the case, for example when participants performed imagery with their sports clothing on and on the training field, hockey penalty flick performance improved more than when imagery was performed at home (Smith et al, 2007). Therefore, it might be beneficial to perform cognitive therapies in the environment that they would normally be performed. For example, whilst imaging or observing an individual sat at a table reaching for a cup, patients should also be sat at a table with a cup in front of them.

The results of the meta-analysis suggest that imagery is more effective at improving movement when performed with physical therapy. Unfortunately, few studies were included in the analysis. It would be beneficial to research whether cognitive therapies are more effective when performed before, during, straight after or without physical therapy. More research is also needed to discover whether neuronal changes can occur when imagery, mirror box therapy and action observation are administered without physical therapy. This will identify whether cognitive therapies should be used with patients who are unable to partake in physical therapy. It is also unknown whether greater muscle activation occurs during cognitive therapies when performed with physical therapy than without physical therapy.

Another factor that could affect muscle activation during imagery and action observation is visual perspective. The meta-analysis indicates that imagery was more effective at improving movement when performed from a third person visual perspective not a first person visual perspective. More research is needed to determine whether imagery and action observation should be performed from a first, third or a combination of both visual perspectives. The use of resistance aids during cognitive therapies could also help improve movement. Currently resistance aids are used during physical therapy sessions (Ouellette et al., 2004), but therapists are not using them during cognitive therapy sessions. It is currently unknown whether the use of resistance aids during cognitive therapies can improve muscle strength and movement ability. Another aspect of cognitive therapy delivery that therapists are not performing according to the literature is therapy duration and frequency. It would be interesting to know why therapists are not adhering to recommendations in the literature. Therapists might not have heard about the recommended therapy duration and frequency advice in the literature or there could be other factors such as time pressures. Further research, as outlined above, in to cognitive therapy delivery and content will help in the development of detailed and effective therapy guidelines.

As well as imagery perspective varying between studies, data were pooled from participants with both left and right hemisphere lesions. Out of the 10 studies that provided information regarding in which hemisphere the lesion was located, 52.2% of participants had a lesion in the left hemisphere (150/287). Pooling data from the wider literature has caused inconsistencies in lesion location. Further research is required to ascertain whether lesion location alters the effectiveness of imagery in improving movement.

5.5.1. Biomechanical movement analysis of stroke-affected individuals. An understanding of how stroke affects movement kinematics is essential in designing and choosing the most effective interventions. It is valuable for therapists to know what movements patients of different severity levels can perform prior to therapy treatment, to enable therapists to design tailor made interventions for each patient. Information regarding patients' movement ability will also help determine cognitive therapy inclusion criteria.

Limited research has been conducted with kinematic analysis in stroke rehabilitation. Although valid measures such as the FMA and the ARAT can be used to measure improvements in movement following the use of cognitive therapy interventions (Page et al., 2007), kinematics may provide a more objective and quantifiable method of measuring changes to movement performance. The FMA and ARAT are sensitive when measuring gross changes in movement but are unable to detect small changes (Reyes-Guzmán et al., 2010), whereas biomechanical analysis and specifically kinematic analysis, is able to precisely detect and describe changes in movement performance (Griffiths, 2006). Research by Subramanian, Yamanaka, Chilingaryan, and Levine (2010) found that sagittal trunk displacement and shoulder flexion, are valid measures of arm motor impairment level post-stroke. A limitation of the study by Subramanian et al. (2010) is that movements occurring at the wrist joint were not measured. It is important for researchers to measure wrist movement following a stroke because individuals affected by stroke sometimes experience spasticity to the affected hand resulting in increased wrist flexion (Barnes & Johnson, 2008). By knowing how hand spasticity alters movement, therapists would know what aspects of upper-limb movement patients need to focus on during cognitive therapies. Therapists might focus on patients visualising and observing wrist extension movements and reduced trunk displacement.

Post-stroke motor impairments can increase movement variability of ADL. Poor task performance can be caused by incorrect limb position during a task. Previous research investigating kinematic analysis of reaching-out and grasping movements have only measured end position static angles (Subramanian et al., 2010) and peak joint angels (Hewett et al., 2007). Measuring peak angles does not account for the dynamic movement patterns occurring throughout the whole range of the reaching tasks. Information regarding patients' whole range of movement will inform therapists of the aspects of movement that patients need to focus on during cognitive therapies. Visualising and observing the whole movement would enable patients to focus on the aspects of movement that needed to improve. Future research into the kinematic analysis of stroke-affected individuals should adopt Reyes-Guzmán et al.'s (2010) data analysis by showing how joint angles alter throughout the whole range of a task.

5.5.2. Neural activation during mirror box therapy. It was hypothesised by Ramachandran and Altschuler (2009) that mirror feedback of the less impaired limb during mirror box therapy might facilitate damaged areas of the sensorimotor network. Neural activation has been exhibited in stroke patients during mirror box therapy (Michielsen et al., 2010). While it is important to know whether mirror box therapy produces neural activation, it is imperative to discover whether mirror box therapy provides muscular stimulation which could help improve movement.

Mirror box therapy has been found to significantly improve Brunnstrom stages and FIM scores in the affected limb of individuals affected by stroke, compared to a control group (Sütbeyaz et al., 2007). Also, this therapy in addition to a conventional stroke rehabilitation programme has been found to improve hand function more than conventional stroke rehabilitation on its own (Yavuzer et al., 2008). However, both Sütbeyaz et al. (2007) and Yavuzer et al. (2008) measured changes in hand function through the use of the FIM and Brunnstrom stage, which are open to subjective interpretation by the researcher.

A less subjective method that could be used to assess the effectiveness of mirror box therapy during stroke rehabilitation is EMG. The benefits of EMG are it can be used to record and analyse the myoelectric signals that are formed by physiological variations in the state of the muscle fibre membrane (Basmaijan & DeLuca, 1985). No previous research has been conducted into the effect of mirror box therapy on muscle activation with individuals affected by stroke. Mirror box therapy during stroke rehabilitation attempts to induce neural activation resulting in motor output, leading to muscle activation and movement (Ramachandran & Altschulter, 2009). However, no research has been conducted into what changes occur in muscle activation during mirror box therapy in individuals affected by stroke. Further research into the effect of mirror box therapy during stroke rehabilitation, will inform therapists of the underlying processes occurring in task-relevant muscles, during mirror box therapy. EMG would also aid in the validation of mirror box therapy. Adding to mirror box therapy knowledge will aid therapists in their understanding of this therapy, and lead to better informed clinical practice.

To summarise, to enable detailed cognitive therapy guidelines to be produced future research is needed to investigate the effects of therapy environment, whether cognitive therapies should be performed before, during, straight after or without physical therapy and therapy visual perspective. Also only limited research has been conducted with kinematic analysis in stroke rehabilitation. Biomechanical analysis, specifically kinematic analysis, is able to precisely detect and describe changes in movement performance (Griffiths, 2006). An understanding of how a stroke affects movement kinematics is essential in designing and choosing the most effective interventions. It is valuable for therapists to know what movements patients of different severity levels can perform and the effect of limb dominance prior to therapy treatment, to enable therapists to design tailor made interventions for each patient. Information regarding patients' movement ability will help determine cognitive therapy inclusion criteria.

No previous research has been conducted into the effect of mirror box therapy on muscle activation with individuals affected by stroke. Mirror box therapy during stroke rehabilitation attempts to induce neural activation resulting in motor output, leading to muscle activation and movement (Ramachandran & Altschulter, 2009). The use of EMG to measure muscle activation would aid in the validation of mirror box therapy.

5.6. Thesis conclusion

Cognitive therapies are practical, inexpensive and can be performed by patients independently. Overall the meta-analysis found that imagery that included task sequencing analysis, specifically focusing on the patients impairments, helped increase movement ability. Performing task sequencing analysis prior to implementing stroke rehabilitation interventions will enable therapists to identify patients' movement weaknesses, allowing imagery interventions and physical practice to be personalised to the patient's needs. Imagery also seems more effective at improving movement when performed with physical practice and from a third person visual perspective. However, patients' imagery perspective preference should be taken into consideration. Imagery does not require any additional equipment, which easily enables imagery to be combined with physical practice. A limited number of studies were used in the meta-analyses focusing on imagery perspective and when imagery should be performed. In addition, the effectiveness of imagery, imagery perspective and when imagery should be performed during stroke rehabilitation is still uncertain, as indicated by the large confidence intervals. Therefore, more research is needed to identify optimal imagery methods post-stroke.

The skill audit showed that therapists are implementing cognitive therapies and understand the benefits of using them. However, therapists need detailed clinical guidelines to inform them of effective therapy techniques and standardise the delivery of cognitive therapies during stroke rehabilitation. Workshops are required that specifically focus on the use of cognitive therapies to improve movement and motivation. By attending workshops, therapists will be informed of current cognitive therapy delivery techniques. This will enable therapists to remain aware of any developments in cognitive therapy delivery and content.

The skill audit found that imagery (68%, 91/133) is used by more therapists than action observation (53%, 68/129) and mirror box therapy (41%, 52/128). The skill audit has identified that not all therapists have access to a mirror box, which prevents the therapists from conducting mirror box therapy. To enable more therapists to deliver mirror box therapy more mirror boxes are needed on stroke wards. As well as mirror box therapy, action observation is also performed by fewer therapists than imagery. Therapists need to be made aware that action observation actually occurs during every physical therapy session, when demonstrations of tasks are provided. Therapists need to be informed of the benefits of action observation, so that they encourage patients to focus on intending to physically performing the demonstrated tasks.

Therapists did not use imagery, mirror box therapy and action observation in isolation but they are being combined. The most common combination of cognitive therapies was imagery and action observation. Action observation was also performed by therapists at the correct duration and frequency as found to be effective in the literature, but imagery and mirror box therapy need to be performed more frequently. To enable imagery and mirror box therapy to be performed more frequently than current practice, but without taking up more of the therapists' time, patients could perform them independently as homework.

Therapists have reported that they use cognitive therapies to motivate patients. To maintain patients' motivation therapists are setting short term and long term goals, providing verbal encouragement and feedback. Patients also perform functional ADL that are meaningful to the patient and are related to their hobbies and interests.

To conclude, the results of the meta-analysis and skill audit will help inform the production of clinical guidelines on the use of cognitive therapies during stroke rehabilitation. The meta-analysis provided new and very useful information on the effectiveness of imagery in stroke rehabilitation. The skill audit provided information regarding cognitive therapy inclusion criteria, therapy delivery, content duration, frequency and how to motivate patients. This information is vital to enable therapists to deliver cognitive therapies effectively.

Chapter Seven: References

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Appendix A: Amsterdam-Maastricht Consensus List Criteria Definitions as Used by Braun et al. (2013)

Item	Rating Criteria
(1A) Randomisation	Item has a positive score if the concealment of treatment allocation is explicitly described to be randomized (e.g., computer generated block randomization) Note: Quasi-randomization is scored negative (e.g., randomization of dates of birth or day of the week)
(1B) Concealment of allocation	Item has a positive score if explicitly is described that the allocation of the intervention was blinded (e.g., an independent assessor performs the allocation and has no information/influence on who will be allocated to which group)
(2) Comparable sub groups at baseline	Item has a positive score if the study groups are comparable at baseline with the most important prognostic factors (e.g., comparable mean age and standard deviation in the study groups)
(3)Blinded care provider	BlindedcareproviderItemhasapositivescoreifthecareproviderisblindedregardingtreatment allocation(e.g.,the care provider is unaware of the content of the intervention*)
(4) Correction for attention; same treatment (dose), co-intervention	Item has a positive score if the different intervention groups have the same treatment dose and if co-interventions are equally divided among the intervention groups. Also, participants in both groups are asked to provide the same information (e.g., fill in logs) and undergo the same tests (battery)
(5) Acceptable compliance	Item has a positive score if participants themselves or therapist and relatives report that the participants followed the given instructions (e.g., through logs, interviews)
(6)Blinded patient	Item has a positive score if patients are blinded regarding treatment allocation and if the method of blinding is appropriate (e.g., the patient is unaware of the treatment content*)
(7) Acceptable withdrawals during intervention period	Item has a positive score if the percentage of patients that drop out of the study does not exceed 10% during the intervention period. Another 10% of loss to follow-up of the remaining sample is set as acceptable for the follow-up period
(8) Blinded outcome assessor	Item has a positive score if the outcome assessors are blinded regarding treatment allocation (e.g., independent raters, who are unaware of the treatment group that the participant is in–preferably checked by asking the rater to predict who is in which group)
(9) Relevance measures	Item has a positive score if the measurement instruments allow answering the research question
(10) Timing assessment	Item has a positive score if the outcome assessment takes place approximately at the same time in all intervention groups. Also, a follow-up period of at least 3 months is set to be acceptable
(11) Intention to treat analysis	Item has a positive score if all randomized patients are reported for all measuring points and are analysed according to the group they were originally randomized to

**Blinding of the care provider and of the patient is not always applicable in physical therapy because of the nature of physical therapy interventions (e.g., manual therapy, exercises). Proper double blinding is therefore unlikely to be achieved for most physical therapy trials (Olivo et al., 2008).*

Appendix B: Sample of the Data Extraction Spreadsheet for Study Liu et al. (2004a)

Study Design

Study Name	Number of Dependant Variables used in the Meta-analysis	Dependant Variables used in the Meta-analysis	Type of Imagery
Liu et.al. 2004a	1	task performance	Task analysis, problem solving, practicing the task mentally

Type of Physical Task	Type of Control	Duration of Intervention (Weeks)	Duration of Imagery (Mins)
Activities of Daily Living	Functional Training on the relearning of the daily living tasks	3	60

Frequency of Imagery (Times per Week)	Average Age of participants	Time since stroke (months)	Location of stroke (left/right/subcortical or bilateral/no data)
5	71.9	0.45	No Data

Number of Males	Number of Females
22	24

Participant Inclusion Criteria: Sustained a unilateral cerebral infraction, age $\geq$ 60 years old, independent in performing daily tasks, able to communicate effectively and give verbal consent.

Data Extracted for Meta-analysis

Study Name	Control Group Participant Number	Control Pre-Intervention Mean	Control Post-Intervention Mean
Liu et.al. 2004	20	3.90	4

Control Pre-Intervention SD	Control Post-Intervention SD	Imagery Group Participant Number	Imagery Pre-Intervention Mean
1.10	0.9	26	3.8

Imagery Post-Intervention Mean	Imagery Pre-Intervention SD	Imagery Post-Intervention SD
5.3	1.2	1

Appendix C: Meta-analysis Calculations

Calculating within-effect estimates

When studies dependant variables had been selected, pre- and post-test effect sizes for each dependent variable, for the treatment and control group were calculated. The pre-test standard deviation was used as the denominator in the effect size equation. The effect size equation was:

$$\frac{\text{Post-test mean} - \text{Pre-test mean}}{\text{Pre-test standard deviation}}$$

Using the experimental group of the study by Page et al. (2001) as an example, the effect sizes were calculated from the results of the treatment group for the ARAT and FMA for upper extremities. The effect size calculations were:

$$\text{ARAT effect size} = \frac{40.40 - 24.05}{13.65} = 1.20$$

$$\text{FMA effect size} = \frac{43.00 - 29.20}{11.40} = 1.21$$

An average effect size of the treatment group was then calculated as there was more than one dependent variable:

$$\text{Average experimental group effect size} = \frac{1.20 + 1.21}{2} = 1.21$$

The between-participant treatment estimate (δ^{u}_{Bi}) was the difference between the treatment and control group effect sizes. The equation was:

$$\delta^{u}_{Bi} = \text{treatment group effect size} - \text{control group effect size}$$

Calculating exact variance

An exact variance calculation was performed due to the relatively small sample sizes used in most studies. This determined the sampling variance of each within-effect estimate. The equation for the exact variance calculation was:

Effect Size = ES

1-(3/((4x(n-1))-1)) = Correction Factor (CF)

Participant group number = n

The population correlation coefficient (Rho) = 0

2 x (1-Rho) = R

CF x ES = Esu

$$\text{Exact variance} = (CF^2) \times (R/n) \times ((n-1)/(n-3)) \times (1+ (n/2) \times Esu^2)-Esu^2/CF^2$$

The exact variance for the between-participant treatment estimate ($V\delta^{u}_{Bi}$) was calculated by summing the control and treatment exact variance values. The exact variance reciprocal (VR) calculation was calculated by dividing one by $V\delta^{u}_{Bi}$. The equation for VR was:

$$\frac{1}{V\delta^{u}_{Bi}}$$

Mean treatment effect calculation

Following the calculation of the VR for each study the δ^{u}_{Bi} was divided by the $V\delta^{u}_{Bi}$ and each studies result was summed together. The mean treatment effect was then calculated and the equation was:

Sum of $(\delta^{u}_{Bi}/V\delta^{u}_{Bi}) = \Sigma BV$

$$\text{Mean treatment effect} = \frac{\Sigma BV}{\Sigma VR}$$

The equation used to weight each study when the random effects model was used is:

Standard Deviation = SD

$$= \frac{1}{(SD^2/n) + \text{Variance}}$$

Upper confidence limit

The equation for the upper confidence limit was:

$$\Sigma(V\delta^{u}{}_{Bi}{}^{2}/(\delta^{u}{}_{Bi}/V\delta^{u}{}_{Bi})) = H$$

Upper confidence limit = Mean treatment effect + (1.96 x H)

Lower confidence limit

The equation for the lower confidence limit was:

Lower confidence limit = Mean treatment effect + (1.96 x H)

Confidence interval

A confidence interval defines a range of values that the mean will fall in. The confidence interval equation was:

$$\text{Confidence interval} = \frac{\text{Upper confidence limit} - \text{Lower confidence limit}}{2}$$

Heterogeneity test (Cochran's Q Statistic)

The Q statistic equation was:

$$\text{Q Statistic} = H-(\sum BV^2)/VR$$

The I^2 Statistic equation was:

Degrees of Freedom = df

$$\text{I2 Statistic} = \frac{(\text{Q statistic - df})}{\text{Q statistic}} \times 100$$

Rosenthal's file draw method

To calculate the number of unpublished studies with trivial effects that would be needed to reduce the observed treatment effect to a trivial level, Rosenthal's file draw method was used. The equation was:

$$\text{Publication Bias} = \frac{\text{Number of studies x (mean treatment effect - 0.15)}}{0.15}$$

Appendix D: Excluded Studies during Screening

Study Name	Study investigating a different topic	Number of participants in a group below 5	No copy of paper
Dunsky et al., 2006		√	
Malouin et al., 2008	√		
Liu et al., 2004b		√	
Page et al., 2001b		√	
Stevens & Stoykov, 2003		√	
Yoo & Chung, 2006		√	
Yoo et al., 2001		√	
Verbunt et al., 2008		√	
Wondrusch and Schuster-Amft, 2013	√		
Braun et al., 2007		√	
Braun et al., 2010	√		
Butler and Page, 2006		√	
Wu, et al., 2011		√	
Dunsky et al., 2006		√	
Dickstein et al., 2004		√	
Deutsch et al., 2012		√	
Schuster et al., 2009		√	
Ietswaart et al., 2006		√	
Timmermans et al., 2013			√
Kim et al., 2009			√
Welfringer et al., 2011	√		
Page et al., 2009	√		

Appendix E: AMCL Quality Assessment of Screened Studies

Author	1(A)	1(B)	2	3	4	5	6	7	8	9	10	11	Total
Ietswarrt et al., 2011	1	1	1	0	1	1	0	0	1	1	1	1	8
Schuster et al., 2012	1	1	1	0	1	1	0	1	0	1	1	1	8
Verma et al., 2011	1	1	1	0	1	1	0	1	0	1	1	1	8
Page et al., 2007	1	0	1	0	1	0	0	1	1	1	1	1	8
Page et al., 2001a	1	0	1	0	1	1	0	1	0	1	1	1	8
Malouin et al., 2009	1	0	1	0	1	1	0	1	0	1	1	1	8
Bovend'Eerdt et al., 2010	1	1	1	0	1	0	0	1	0	1	1	1	7
Liu et al., 2004a	1	1	1	0	1	0	0	1	0	1	1	1	7
Cho et al., 2013	1	1	1	0	1	0	0	1	0	1	1	1	7
Hosseini et al., 2012	1	1	1	0	1	0	0	1	0	1	1	1	7
Liu et al., 2009	1	1	1	0	1	0	0	1	0	1	1	1	7
Hwang et al., 2010	1	0	1	0	1	0	0	1	0	1	1	1	7
Page et al., 2005	1	0	1	0	1	0	0	1	0	1	1	1	7
Dickstein et al., 2013	1	0	1	0	1	0	0	1	0	1	1	1	7
Müller et al., 2007	1	0	1	0	1	0	0	1	0	1	1	1	7
Riccio et al., 2010	1	0	1	0	1	0	0	1	2	1	1	1	7
Dijkerman et al., 2004	0	0	1	0	1	0	0	1	0	1	1	1	6
Guttman et al., 2012	0	0	1	0	1	0	0	1	0	1	1	1	6
Santos-Couto-Paz et al., 2013	0	0	1	0	1	0	0	1	0	1	1	1	6
Page, 2000	1	0	1	0	1	0	0	0	0	1	1	1	5.5
Lee et al., 2011	1	0	1	0	0	0	0	1	0	1	1	1	5.5
Dunsky et al., 2008	0	0	1	0	0	0	0	1	0	1	1	1	5
Malouin et al., 2004	0	0	1	0	0	0	0	1	0	1	1	1	5
Simmons et al., 2008	0	0	1	0	0	0	0	1	0	1	1	1	5
Craje et al., 2010	0	0	1	0	0	0	0	1	0	1	1	1	5
Hewett et al., 2007	0	0	1	0	0	0	0	1	0	1	1	1	5
Crosbie et al., 2004	0	0	0	0	0	1	0	1	0	1	1	0	4
Malouin et al., 2004	0	0	0	0	0	0	0	1	0	1	1	1	4

AMCL criteria: (1A) Randomisation; (1B) Concealment of allocation; (2) Comparable sub groups at baseline; (3)Blinded care provider; (4) Correction for attention; same treatment (dose), co-intervention; (5) Acceptable compliance; (6)Blinded patient; (7) Acceptable withdrawals during intervention period; (8) Blinded outcome assessor; (9) Relevance measures; (10) Timing assessment; and (11) Intention to treat analysis. When the article fulfilled the criterion it scored 1 point. If the study did not fulfil the criterion or it was unclear the article scored zero. Criteria 1(A) and 1(B) only score half a point if positive.

Appendix F: Imagery Meta-analysis Participant Inclusion Criteria

Study	Participant inclusion criteria
Verma et al., 2011	(1) Sustained a unilateral stroke with hemiparesis during the last month; (2) functional ambulation classification level II and above; (3) ability to understand instructions (Hindi mental state examination [HMSE] >24; (4) ambulatory before stroke, so they are able to cope with the training programme; (5) able to perform imagery (Movement Imagery Questionnaire- revised second version [MIQ-RS] $\geq$ 25); (6) National Institutes of Health Stroke Scale (NIHSS) score less than 14; and (7) no history of neurological disease, conditions affecting balance, neglect, visual impairment, musculoskeletal conditions affecting lower limbs and cardiac instability or serious cardiac conditions.
Santos-Couto-Paz et al., 2013	(1) Aged between 20 and 60 years; (2) time since stroke at least six months; (3) had dominant upper-limb impairment; (4) no serious cognitive deficits (minimum score of 18 on the Mini-Mental Status Examination [MMSE]); (5) ability to demonstrate active flexion of the paretic wrist and the metacarpophalangeal and interphalangeal joints of the index and thumb of at least 10°; (6) had received prior strengthening and stretching-based physiotherapy; (7) participants were excluded if they scored ≥3 on the modified Ashworth Scale16, excessive pain in their paretic upper limb (scores ≥4 on the 10-point visual analog scale), had difficulty in performing imagery (MIQ-RS) and had any other neurological disorders.
Liu et al., 2004a	(1) Sustained a unilateral cerebral infraction; (2) age $\geq$ 60 years old, independent in performing daily tasks; and (3) able to communicate effectively and give verbal consent.
Page et al., 2001a	(1) Stroke experienced greater than 4 weeks prior to participation but no more than a year; (2) no serious sensory or cognitive deficits (minimum score of 20 on the MMSE); (3) lesions not affecting both hemispheres or hemorrhagic lesions; (4) no serious spasticity; (5) no receptive aphasia present; and (6) good imagery ability (score higher than 25 on MIQ).
Page et al., 2007	(1) Have only experienced one stroke >12 months prior to participation; (2) able to flex at least 10^o from neutral at the affected wrist and fingers; (3) score $\geq$69 on the modified MMSE; (4) age >18 and <80 years, no serious spasticity or pain and not enrolled in physical rehabilitation; and (5) experimental rehabilitation or drug studies.

Study	Participant inclusion criteria
Lee et al., 2011	(1) Hemiparetic from a single stroke occurring at least six months earlier; (2) able to walk 10m independently without an assistive device; (3) MMSE scores of 24 or higher; (4) no known musculoskeletal conditions that would affect the ability to safely walk repeatedly; and (5) absence of serious visual or hearing impairment.
Hwang et al., 2010	(1) Six months or more post-stroke; (2) able to walk 10m with or without aids, no cognitive impairments (scores above 24 on the MMSE); (3) able to understand verbal instructions, no cerebellar lesion; (4) no significant body or visuospatial hemineglect; and (5) good imagery ability (score higher than 32 on MIQ-RS).
Dijkerman et al., 2004	(1) Encounter upper-limb limitations; (2) is able to perform tokens and blocks moving task; and (3) no severe motor impairments.
Schuster et al., 2012a,b	1) First ischemic or hemorrhagic stroke at least 3 months before; (2) able to stand with or without a cane for at least 30 seconds; (3) able to walk 20 metres with or without a cane or an orthosis; (4) older than 18 years; (5) score at least 20 on the MMSE; and (6) patients were excluded if they had joint replacements (knee, hip, shoulder), motor task limiting pain in the upper or lower body evaluated with the 11-point visual analogue scale, had limited range of motion in the hip, knee, ankle joints or toes, bodyweight exceeding 90 kilograms, or had a comprised mental capacity to give written informed consent.
Ietswaart et al., 2011	(1) Stroke occurred 1-6 months prior to participation; (2) Action Research Arm Test (ARAT) between 3-51; (3) no alcohol or substance abuse; (4) no severe cognitive impairment (Mental Status Questionnaire 7 or more); and (5) no severe aphasia (using 10 items of the language comprehension Token Test).
Dickstein et al., 2013	(1) Aged 60 to 80 years; (2) had sustained a unilateral stroke at least 6 months and no more than 2 years before recruitment; (3) subjects reported limited indoor and outdoor ambulation because of the stroke; (4) MMSE score was 24 points or higher; (5) were not receiving physical therapy; and (6) where excluded if they used a wheelchair, severe ailments including psychiatric disorders and major depression, and communication deficits.
Bovend’Eerdt et al., 2010	(1) Had a positive score for the first three items of the Sheffield screening test for language disorders; (2) and had no comorbidity that would interfere with imagery ability.

Appendix G: Ethics Acceptance Letter

Hi Christine,

Thank you for the swift turn around on the modifications to the ISP for study **11.07.11(i)**. All the issues have now been addressed and I'm able to approve the ethics application via Chair's Action.

Good luck with the research.

Nick

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Appendix H: Skill Audit Pilot Questionnaire

1. How long did the questionnaire take to complete? _____ minutes

---

2. Were the instructions clear? Yes ☐ No ☐

If no:

Which instructions were not clear?

How could the instructions be improved?

---

3. Was the terminology appropriate? Yes ☐ No ☐

If no:

Which terminology was inappropriate?

Which terms could/should be substituted?

---

4. Were any questions ambiguous? Yes ☐ No ☐

If yes:

Which questions were ambiguous?

How could the question be improved?

---

5. Did the questions seem relevant to the study title/aims and objectives? Yes ☐ No ☐

If no:

Which questions were irrelevant?

How could the question be made more relevant?

6. Did any of the questions offend you or have the potential to offend others?	Yes ☐	No ☐

If yes:

Which questions offended you?

How could the questions be modified so that they do not offend?

7. Did you object to answering any questions?	Yes ☐	No ☐

If yes:

Which questions did you object to answering?

How could the question be improved?

8. Was the layout clear?	Yes ☐	No ☐

If no:

How could the layout be made clearer?

9. Was the layout attractive? Yes ☐ No ☐

If no:

How could the layout be made more attractive?

10. Was it easy to log on to and complete the online survey? Yes ☐ No ☐

If no:

What problems did you experience when logging on to the online survey?

How could these problems be improved?

11. Any other comments?

Thank you again for your time. Your comments will be most helpful.

Appendix I: Pilot Skill Audit

Imagery in Stroke Rehabilitation

The MMU stroke research group is investigating physiotherapists' and occupational therapists' use of imagery in stroke rehabilitation. We are inviting you to complete this questionnaire as part of a national survey as you have experience of working with stroke patients.

Please tick the box which refers to the most appropriate answer for you, except when the question specifies that you can choose more than one answer. When you have completed the questionnaire please post it back to us in the envelope provided. There are no right or wrong answers and all your answers will remain anonymous and confidential throughout the study. You are free to discontinue participation at any time without prejudice.

An online version of this questionnaire is available at http://www.kwiksurveys.com/online-survey.php?surveyID=HKMKFN_5f1c262f should you wish to complete the questionnaire in a different format. If there are any problems or you have any questions, do not hesitate to contact us at the address provided below.

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Part A

1. Are you a physiotherapist or an occupational therapist?

Physiotherapist ☐ Occupational therapist ☐

If you are not a physiotherapist or an occupational therapist working in stroke rehabilitation, we would be grateful if you could pass the questionnaire to a physiotherapist or occupational therapist who works in your stroke rehabilitation unit. If you are a physiotherapist or an occupational therapist working in stroke rehabilitation please carry on to question 2.

2. Please confirm your current Agenda for Change pay scale:

5 ☐ 6 ☐ 7 ☐ 8a ☐ 8b ☐

3. How long have you been qualified as a physiotherapist or occupational therapist?

< 1 year ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ 20+ years ☐

4. How long have you been involved in working with stroke patients?

< 1 year ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ 20+ years ☐

5. Approximately how many hours, in a typical 7.5 hour working day, do you spend working with stroke patients?

< 1 hour ☐ 1-3 hours ☐ 3-5 hours ☐ >5 hours ☐

6. When talking to patients, do you discuss their pre-stroke activities of daily living?

YES ☐ NO ☐

7. If you answered “YES” to question 6, do you reflect on their responses and use them in your subsequent therapy sessions, e.g. to direct the content of your therapy?

YES ☐ NO ☐

Part B

In part B we wish to explore which cognitive therapies you use. We describe cognitive therapies as structured therapy that attempts to change positively the patient's thoughts, emotions and behaviours. There may be associated changes in physical function and behaviour.

8. Do you believe you use cognitive therapies as part of your work?

No ☐ Rarely ☐ Sometimes ☐ Frequently ☐

Cognitive therapies may include some of the following, please tick any you have used.

- Imagery ☐
- Cognitive behavioural therapy (CBT) ☐
- Rational emotive behavior therapy (REBT) ☐
- Rational emotive therapy ☐
- Cognitive analytic therapy ☐
- Psychodynamic therapy ☐
- Humanistic therapy ☐
- Interpersonal therapy ☐
- Mindfulness-based therapies ☐
- Motivational counselling ☐
- Other (please state) ____________________________________

If you are unsure which category your cognitive therapy falls into please describe in the box provided below.

9. Have you received any formal qualifications for the above therapies?

YES ☐ NO ☐

10. If you answered "YES" to question 11 please state the formal qualifications that you possess in the box provided below.

11. We are interested in your use of imagery as a therapeutic intervention. We define imagery ***"as the use of any and/or all of the senses to create or recreate an experience in the mind."*** Other terms used to describe this include visualisation, mental practice, mental rehearsal and mental simulation. Please answer the following questions regarding your use of imagery in your work.

Have you heard of the use of imagery in rehabilitation for stroke patients?

YES ☐ NO ☐

If answered "YES", please go to q. 12. If "NO", please go to q. 23.

12. Where did you first learn about this intervention?

During undergraduate training ☐

During postgraduate training ☐

Colleague(s) ☐

Patient(s) ☐

Professional and/or scientific journal ☐

Popular media (e.g. newspaper or magazine article, television) ☐

Other (please state) ______________________________

13. Have you used imagery to supplement your therapy practice?

YES ☐ NO ☐

If answered "YES", please go to q. 14. If "NO", please go to q. 23.

Part C

14. With approximately what percentage of stroke patients do you use imagery?

0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100% ☐

15. With a "typical" stroke patient, how many times per week would you use imagery?

0-3 ☐ 4-6 ☐ 7-9 ☐ 10+ ☐

16. How many minutes would your typical imagery session last?

0-10 ☐ 11-20 ☐ 21-40 ☐ 41-60 ☐ > 60 ☐

17. When using imagery during a treatment session do you ask patients to think about activities that they used to be able to perform?

YES ☐ NO ☐

18. How do you deliver your imagery interventions?

by health care professional ☐ by the patient outside formal therapy sessions ☐ both ☐

19. When you conduct an imagery session do you ask patients to image from a first person visual perspective (i.e. as if looking through their own eyes) ☐

OR

A third person visual perspective (i.e. imaging themselves/ or another person from the perspective of an external observer) ☐

OR

Both perspectives ☐

OR

I don’t specify which perspective to use ☐

20. Who chooses the content of the imagery?

You ☐ Patient ☐ Both ☐

21. What is the content of the imagery based upon?

Past experiences ☐ Present activities ☐ Future aspirational activities ☐

22. Do you develop a written imagery script? (i.e. write down what you want the patient to image.)

YES ☐ NO ☐

23. There is evidence that imagery may be a useful addition to therapy. With guidance if needed, would you consider using imagery as a supplement to your physical stroke rehabilitation therapies?

YES ☐ NO ☐ NOT SURE ☐

24. Would you be interested in receiving information on imagery as a supplement to your physical stroke rehabilitation therapies?

YES ☐ NO ☐ NOT SURE ☐

25. If “YES”, what would be your preferred mode of information delivery? (Please tick all that apply)

Seminar/workshop ☐

Internet-based seminar/workshop ☐

Resource pack including written materials and DVD(s) ☐

Other (please state) ________________________________

26. Would you be willing to take part in a follow-up interview or focus group on this topic?

YES ☐ NO ☐

Please provide a 6 digit unique identifying code of your choice in the box below.

☐

Thank you for your time and participation

Appendix J: Final Skill Audit

Imagery, mirror box therapy and action observation in stroke rehabilitation

Part A

1. Are you a physiotherapist or an occupational therapist?

Physiotherapist ☐ Occupational therapist ☐

If you are not a physiotherapist or an occupational therapist working in stroke rehabilitation, we would be grateful if you could pass the questionnaire to a physiotherapist or occupational therapist who works in your stroke rehabilitation unit. If you are a physiotherapist or an occupational therapist working in stroke rehabilitation please carry on to question 2.

2. Please confirm your current Agenda for Change pay scale:

5 ☐ 6 ☐ 7 ☐ 8a ☐ 8b ☐

3. How long have you been qualified as a physiotherapist or occupational therapist?

< 1 year ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐

20+ years ☐

4. How long have you been involved in working with stroke patients?

< 1 year ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐

20+ years ☐

5. Approximately how many hours, in a typical 7.5 hour working day, do you spend working directly face-to-face with stroke patients?

< 1 hour ☐ 1-3 hours ☐ 3-5 hours ☐ >5 hours ☐

6. When talking to patients, do you discuss their pre-stroke activities of daily living?

YES ☐ NO ☐ SOMETIMES ☐

7. If you answered "YES" to q. 6, do you reflect on their responses and use them in your subsequent therapy sessions, e.g. to direct the content of your therapy?

YES ☐ NO ☐ SOMETIMES ☐

Part B

In part B we wish to explore which cognitive therapies you use. We describe cognitive therapies as ***"structured therapy that attempts to change positively the patient's thoughts, emotions and behaviours. There may be associated changes in physical function and behaviour."***

The cognitive therapies that we are interested in are imagery, mirror box and action observation. Below are definitions of the 3 cognitive therapies:

Imagery – "*the use of any and/or all of the senses to create or recreate an experience in the mind."* Other terms used to describe this include visualisation, mental practice, mental rehearsal and mental simulation.

Mirror box – "*the use of a mirror in the sagittal plane to provide visual feedback from the reflection of the non-affected limb. This accesses body parts that are otherwise not accessible."* Other terms used to describe this include mirror visualization therapy.

Action observation – *"the observation of movements with the intent to imitate."*

8. Which therapies have you heard of?

Imagery YES ☐ NO ☐

Mirror box YES ☐ NO ☐

Action observation YES ☐ NO ☐

If you answered "YES" to any of the therapies above please go to q.9. If "NO", please go to q.30.

9. Where did you first learn about these interventions?

	Imagery	Mirror box	Action observation
During undergraduate training	☐	☐	☐
During postgraduate training	☐	☐	☐
Colleague(s)	☐	☐	☐
Patient(s)	☐	☐	☐
Professional and/or scientific journal	☐	☐	☐
Popular media (e.g. newspaper or magazine article, television)	☐	☐	☐

Other (please state) ______________________________

10. Have you been to any workshops about the above therapies?

YES ☐ NO ☐

11. If you answered "YES" to q. 10 please state the workshop you attended in the box provided below.

12. Which therapies have you used?

	Imagery	Mirror box	Action observation
YES	☐	☐	☐
NO	☐	☐	☐

If you have answered "YES" to any of the therapies, please go to q.13. If "NO" to all therapies, please go to q.30.

13. Which cognitive therapy do you find most effective in improving hand function?

- Imagery ☐
- Mirror box therapy ☐
- Action Observation ☐

14. Which cognitive therapy do you find most effective in improving leg function?

- Imagery ☐
- Mirror box therapy ☐
- Action observation ☐

15. With approximately what percentage of stroke patients do you use imagery, mirror box or action observation?

	Imagery	Mirror box	Action observation
0-20%	☐	☐	☐
21-40%	☐	☐	☐
41-60%	☐	☐	☐
61-80%	☐	☐	☐
81-100%	☐	☐	☐

16. With a "typical" stroke patient, how many sessions per week would you use imagery, mirror box or action observation?

	Imagery	Mirror box	Action observation
1	☐	☐	☐
2	☐	☐	☐
3	☐	☐	☐
>3	☐	☐	☐

17. How many minutes would your typical therapy session last?

	Imagery	Mirror box	Action observation
1-10	☐	☐	☐
11-20	☐	☐	☐
21-30	☐	☐	☐
31-40	☐	☐	☐
> 40	☐	☐	☐

18. How do you deliver your imagery, mirror box or action observation therapies?

	Imagery	Mirror box	Action observation
by health care professional	☐	☐	☐
by the patient outside formal therapy sessions	☐	☐	☐
both	☐	☐	☐

19. When you conduct an imagery or action observation session do you ask patients to image from a first person visual perspective (i.e. as if looking through their own eyes)

	Imagery	Action observation
	☐	☐

OR

A third person visual perspective (i.e. imaging themselves/ or another person from the perspective of an external observer)

	Imagery	Action observation
	☐	☐

OR

Both perspectives

	Imagery	Action observation
	☐	☐

OR

	Imagery	Action observation
I don't specify which perspective to use	☐	☐

20. Who chooses the content of the imagery, mirror box or action observation?

	Imagery	Mirror box	Action observation
You	☐	☐	☐
Patient	☐	☐	☐
Both	☐	☐	☐

21. What is the content of the imagery, mirror box or action observation based upon?

	Imagery	Mirror box	Action observation
Past experiences	☐	☐	☐
Present activities	☐	☐	☐
Future aspirational activities	☐	☐	☐

22. Do you use imagery, mirror box or action observation to motivate stroke patients?

	Imagery	Mirror box	Action observation
YES	☐	☐	☐
NO	☐	☐	☐
SOMETIMES	☐	☐	☐

23. If you answered "YES" to q. 22 how do you motivate the patients? Write in the box provided below.

Part C

Part C includes specific questions about imagery and mirror box. If you use imagery to supplement your therapy practices carry on to q. 24. If you only use mirror box go to q. 26. If you use neither imagery nor mirror box go to q.30.

24. What do you emphasise when using imagery? Please tick any that you use.

Imagery of physical movement used in therapy sessions ☐

Imagery of activities of daily living ☐

Goal setting ☐

Visual (what patients see when physically performing the task) ☐

Kinaesthetic (what patients feel when physically performing the task) ☐

Physical motivation ☐

25. Do you develop a written imagery script? (i.e. write down what you want the patient to image.)

YES ☐ NO ☐ SOMETIMES ☐

26. Do you use the flash cards at the start of every mirror box therapy session or just until they can distinguish between their left and right?

Every therapy session ☐ Until they can distinguish between their left and right ☐

Do not use ☐

27. During the mirror box therapy sessions do you get the patient to visualise themselves moving their hand into positions that they might find uncomfortable?

YES ☐ NO ☐

28. During the mirror box therapy sessions do you get the patient to do bilateral movements (i.e. the same movement in the left and right side of the body at the same time?)

YES ☐ NO ☐

29. Do you use resistance aids such as a sponge, to squeeze during your mirror therapy sessions?

YES ☐ NO ☐

30. There is evidence that imagery, mirror box and action observation may be a useful addition to therapy. With guidance if needed, would you consider using them as a supplement to your physical stroke rehabilitation therapies?

	Imagery	Mirror box	Action observation
YES	☐	☐	☐
NO	☐	☐	☐
NOT SURE	☐	☐	☐

Please include any additional information about your therapy practice in the box provided below.

Please provide a 6 digit unique identifying code of your choice in the box below.

Thank you for your time and participation

Appendix K: Skill Audit Qualitative Analysis for the Motivation Question

The first grouping stage of comments made by 48 therapists on how they motivate their patients with cognitive therapies:

Tasks

653123 **-** Use functional tasks such as reaching for- Cup.

311090- relaxation to reduce anxiety.

53- using positive past activities (imagery).

53- Include movements been worked on in therapy that are achievable to encourage positive reinforcement (action observation).

589222 - To think and feel the experience 100% using all senses vision, touch, smell, taste (if appropriate), sound.

120500 - Relate to activities of daily living.

100405 - By using the techniques, patients can visualise what they need to do and can see how it can be put into functional tasks.

246810- It's more that engaging in these therapies is motivating for patients.

30796 - Motivate pt by using positive -experiences during imagery session.

318- guided imagery to encourage patient to explore own images and actions.

121974 - Through visual imagination of upper limb activity, functional task. Also in sensory re-education training.

Goal setting

123457 - If a patient wants to be able to do that task function and it is their goal then are keen to try any technique that may help them to do this.

53- Always work to achievable goals.

267267- the patient can use current goals/long term goals that help them to believe they can progress.

984253 - Goal setting.

53- Goals set by patients.

495862 – use goal orientated approach. Sometimes create a "contract" with pt, detailing agreed goals + 4 sessions with pt on a daily/wkly basis.

39 – Goal setting.

12398 - by setting achievable goals (pt specific) maintaining realistic goals and ensuring their flexible.

Education

220322 - Our junior physiotherapist who had a 1st degree in sports studies had been taught imagery in sports context. He did a literature search and produced a leaflet and provided an in-service for the physiotherapy/stroke unit. We provide the patients with an informal discussion about the use of imagery in sports to produce better results and explain this may also work for them.

221267 - By explaining the benefits of the activities in improving their motor control/function.

456765- by explaining that research suggests imaging the movement the patient wishes to achieve can help to light up areas of the brain and therefore help improve chances of recovery.

444888- I explain how paper written on mirror box and imagery have been shown to work at switching on remaining cells to get them to do new work. Give examples of how it has helped others.

675542 - Suggest that use will help regain movement according to research.

39- Education.

776669 - by educating them about how it is beneficial.

91062 - Explain concept behind especially for mirror box.

61075- Talking the guidance through with the patient.

50386- Use education of the concepts and how they can be effective to gain motivation.

222952 - I Explain the rationale of why is has been proven to be useful.

111111- Education.

Meaningful/personalisation

653123- Use hobbies, interests.

220322- We discuss with the patient the activity they want to do.

53- If they are a keen cook, I may concentrate on kitchen activities, if a golfer, the golf swing etc.

7 - By orientating tasks on those most meaningful for patients.

120500- activities they need to perform in future/ on discharge.

100000- allowing them (patient) to take control over the session.

495862- use client centred.

39- activities of interest to pt.

140387 - link it hobbies/interest.

30796- imagery sessions should be in a realistic context that is meaningful to the individual.

246090 -use of activities they like to improve.

120500- activities they need to perform in future/ on discharge.

Therapy patients can perform by themselves

220322- encourage them to use imagery outside of therapy time.

102011- enables patients to do something for themselves/ with family to help with their recovery, especially when they have little/no movement.

221267- Patients feel they are helping their recovery and it is something that even severe strokes can achieve independently.

93690- Some patients then go on to purchase a mirror box or persevere with imagery at home which helps with their motivation.

456765- offering something the patient can do without needing supervision which may benefit them I hope that this motivates patients.

917624 - It is something the patient can do themselves in their own time to aid recovery.

243218 - Increase motivation if pt feel increase control over their recovery - something they can do to help. Proactive rather than passive.

246810- It's motivating to know that they can participate in their own recovery.

776669- by educating patients they are actively doing something to help their c/c even if there is no active/ selective movement.

404328 - Using this technique provides some hope for patients with no active movement in their upper limb. It involves them and their family/ partner in actually carrying out treatment themselves, outside of therapy sessions, so they feel they are getting more therapy.

10684 - Mirror box - To give them something outside of therapy that they can safely work on by themselves.

91062- Encourage pt to complete tasks outside therapy sessions. - Involve family in using mirror box.

771116 - Mirror box: I often educate family members and do joint sessions with them.

111111- Encourage self-regulation.

81275 - Feel they are actively participating and movement of limb even if passive.

Positive encouragement

300578- Patients who are part of the MAESTRO trial are usually prompted to do exercises.

53- Give lots of positive feedback and verbal encouragement.

456765- encourage them to continue to do it.

310586- saying such motivational words.

444888- Always stress the positive-any new movements.

120403 - Encourage increased activity - positive therapy.

10684- Action observation - To praise return of movement.

318 - Verbal encouragement.

Positive reinforcement

100405 – using the techniques encourages them and makes them fell positive about movements/activities which may feel distant or futile to them.

61075- Give positive reinforcement.

30796- use of positive reinforcement during session.

Improving confidence

221267- when patients feel that they are helping their recovery their self-efficacy improves.

310586 - As they get a visual feedback we boost up their confidence that they can do it.

310586- push their confidence by saying such motivational words.

Improving mood

221267- when patients feel that they are helping their recovery their mood improves.

1704- Positive Mental Attitude.

Progress

310586- see you have got some movement.

310586- make them see through visual feedback that their effort is worth and they are getting some movement.

Feedback

142609 - As a positive feedback when activity is achieved.

50386- feedback/show them results to keep motivation.

111111-Feedback

246090- positive feedback after practical session.

Performing tasks that may aid recovery

51878- applying a technique that may aid their recovery.

444888 - I ask them to take part in the session to improve their function.