EXERCISERS' IMAGERY USE AND ABILITY

By

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ABSTRACT

There are many health benefits with regular physical activity. Despite this, physical inactivity is a global health problem. It is therefore important to find ways of helping people become more physically active and maintain this behaviour over time. Imagery could be used to increase exercise adherence, but more research is necessary for it to be used in the best way. The aim of this thesis was to examine tenets of the revised applied model of deliberate imagery use in the exercise domain. Two studies were carried out to investigate whether: (1) a brief period of imagery rehearsal could increase barrier self-efficacy in women who want to exercise more; and (2) if it is feasible to improve imagery ability among women who want to exercise more through imagery training and one week of guided rehearsal. The studies were the first to improve barrier self-efficacy, affective responses, and imagery ability using a brief imagery intervention.

PUBLICATIONS AND CONFERENCE PRESENTATIONS

The following publications and abstracts were accepted for publication and/or presentation at scientific meetings during the time of the MPhil.

Publication that are part of this thesis

Study 1 (Chapter 2): Weibull, F., Cumming, J., Cooley, S. J., Williams, S. E., & Burns, V. E. (2014). Walk this Way: A Brief Exercise Imagery Intervention Increases Barrier Self-Efficacy in Women. Current Psychology. *34*(*2)*, 477–490. doi:10.1007/s12144-014-9271-0.

Study 2 (Chapter 3): Weibull, F., Cumming, J., Cooley, S. J., Williams, S. E., & Burns, V. E. (2017). Examining the Feasibility of a Short Intervention for Improving Exercise Imagery Ability. *Journal of Imagery Research in Sport and Physical Activity, 12*(1). Published online. doi.org/10.1515/jirspa-2016-0008

Additional publications

1. Cumming, J., Cooley, S. J., Anuar, N., Kosteli, M., Quinton, M. L., **Weibull, F.**, & Williams, S. E. (2017). Developing Imagery Ability Effectively: A Guide to Layered Stimulus Response Training. *Journal of Sport Psychology in Action*, *8*(1), 23-33. doi:10.1080/21520704.2016.1205698

2. Franck, A., Stambulova, N., & **Weibull, F.** (2016). Profiles of personal characteristics relevant pathways in the junior-to-senior transition: A longitudinal study of Swedish athletes. *International Journal of Sport Psychology*, *47* (6), 483-507.

3. Williams, S.E., Cooley, S.J., Newell, E., **Weibull, F.**, & Cumming, J. (2013). Seeing the Difference: Developing Effective Imagery Scripts for Athletes. *Journal of Sport Psychology in Action, 4*(2), 109-121.

4. Stambulova, N., Franck, A., & **Weibull, F.** (2012). Assessment of the transition from junior to senior sports in Swedish athletes. *International Journal of Sport & Exercise Psychology, 10*(2), 1-17.

5. **Weibull, F**., Wallsbeck, M., Almgren, A. (2012). *Träna tanken – mentala föreställningar i idrotten*. Stockholm: SISU idrottsböcker.

Conference presentations

1. **Weibull, F**., Burns, V. E., & Cumming, J. (2015, July). *Does exercise imagery mediate the relationship between exercise behavior and affective outcomes?* Poster session presented at the 14th European Congress of Sport Psychology, Bern, Switzerland.

2. **Weibull, F**., Cumming, J., Burns, V. E. (2015, May). *Exercise Imagery Mediates the Relationship Between Exercise Behaviour and Affective Outcomes*. Presentation at the meeting of the Research in Imagery and Observation Group, University of Stirling, Stirling.

3. **Weibull, F**., Cumming, J., Williams, S. E., Cooley, S., Burns, V. E. (2014, May). *How to develop exercise imagery ability*. Presentation at the meeting of the Research in Imagery and Observation Group, Université Catholique de Louvain Clinics of Saint-Luc, Brussels.

4. **Weibull, F.**, Cumming, J., Williams, S. E., Cooley, S. J., & Burns, V. E. (2012, April). *Improving exercise imagery ability in insufficiently active women: A brief imagery intervention*. In S. E. Williams (Chair), *Imagine that! Developing imagery ability in sport, exercise, and dance*. Symposium conducted at the meeting of the British Psychological Society Annual Conference, London.

5. Cumming, J., Williams, S. E., **Weibull, F**., & Cooley, S. J. (2012, April). *Moving forwards: Imagery ability research in sport, exercise and dance*. In S. E. Williams (Chair), *Imagine that! Developing imagery ability in sport, exercise, and dance*. Symposium conducted at the meeting of the British Psychological Society Annual Conference, London.

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Chapter 1

GENERAL INTRODUCTION

Research has demonstrated that an inverse relationship exists between physical activity and mental health (Galper, Trivedi, Barlow, Dunn, & and Kampert, 2006) and that there are many benefits to regular physical activity, such as a reduced risk of stroke, high blood pressure, breast and colon cancer, coronary heart disease, type 2 diabetes and depression (Powell, Paluch, & Blair, 2011). At the same time, it is estimated that physical inactivity causes 5-10 % of the major non-communicable diseases of type 2 diabetes, breast and colon cancers and coronary heart disease (Lee, Shiroma, Lobelo, Puska, Blair, & Katzmarzyk, 2012). Even though these facts have been known for a long time, physical inactivity continues to be a major global health problem (Trost, Blair, & Khan, 2014) and adherence to exercise programs needs to be improved.

One of the major challenges when it comes to helping people become more physically active is initiation, in which, the individuals take an active decision and start exercising. The next challenge is to keep them physically active, that they continue to exercise. A number of factors influence if people continue to exercise once they have started. Common motivators to exercise are release of tension, social experience, health, and fitness (Biddle & Bailey, 1985; Cohen-Mansfield, Marx, & Guralnik, 2003), while common barriers are lack of time, lack of confidence, lack of motivation, health problems, lack of interest/other interests, not in the mood, and lack of energy (Allison, Dwyer, & Makin, 1999; Cohen-Mansfield, Marx, & Guralnik, 2003, Silliman, Rodas-Fortier, & Neyman, 2004; Tappe, Duda, & Ehrnwald, 1989; Withall, Jago, & Fox, 2011). For continued exercise participation, the belief in one's ability to deal with and preserver despite these barriers is important.

A technique which could be used to deal with the challenges mentioned above is imagery. Research has shown that it can be used to influence people's emotive experience of exercise and initial research supports this notion (e.g., Stanley & Cumming, 2010a).

Here is an exercise specific definition of imagery, originally developed by Giacobbi, Hausenblas, Fallon, & Hall (2003, p. 162) and later modified by Kim and Giacobbi (2009, p. 5).

> Imagery involves mentally seeing yourself exercising. The image of your mind should approximate the actual physical activity as close as possible. Imagery may include sensations like hearing the music, feeling yourself move through the exercises, and feeling your heart beating. Imagery can also be associated with emotions. Some examples are imagining yourself getting psyched up or energized and feeling exhilarated after a workout. Imagery can also be used as a motivation to exercise. Some examples of motivational imagery are staying focused on exercise and not being distracted, setting exercise plans and goals such as imaging achieving goal of losing weight. Imagery can also be used to imagine proper form, technique, and routines.

The aim of this chapter is to review the literature on exercise imagery and outline the rationale for the present thesis. The first section will provide an overview of the physical inactivity problem, then exercise imagery will be introduced as a way to promote more physical active lifestyles. This is followed by a description of exercise imagery models. Finally, there will be a review of the exercise imagery literature.

Exercise imagery

During the last two decades, researchers have started to investigate how imagery can be used in the exercise domain. One of the main objectives with this research is to help individuals increase their exercise adherence. Imagery can be used to improve self-efficacy (Duncan, Rodgers, Hall, & Wilson, 2011) and affective responses to exercise (e.g., Stanley & Cumming, 2010). This in turn will help individuals to continue exercising because they believe it is something they can manage (e.g., Lee, Arthur, Avis, & 2008) and enjoy (e.g., Kahneman, 1999). Enjoyment and what feels good influence decision making. People tend to do what they enjoy to do and stop doing what they do not enjoy (Kahneman, 1999).

Hall (1995) initially proposed the possibility of extending the benefits of imagery in sport to the exercise domain. He suggested that imagery might increase exercise motivation through its influence on self-confidence and outcome expectancy. Following the publication of Hall's seminal paper, the first studies in the area were conducted. These studies focused on how exercisers use imagery (Hausenblas, Hall, Rodgers, & Munroe, 1999; Gammage, Hall, & Rodgers, 2000), the development of exercise imagery-use questionnaires (e.g., Hausenblas, Hall, Rodgers, & Munroe, 1999), and the relationships between exercise imagery and variables such as exercise addiction (e.g., Hausenblas & Symons Downs, 2002).

The first questionnaire developed was the Exercise Imagery Questionnaire (EIQ; Hausenblas et al., 1999; Rodgers, Hall, Blanchard, & Munroe, 1999). The EIQ was originally designed to examine the imagery use of aerobic exercisers before it was later modified to also fit other type of exercise activities (Rodgers et al., 1999). It was designed to measure the most common functions of exercise imagery use: energy, technique, and appearance imagery. Research using the EIQ has clearly demonstrated that exercisers most frequently use appearance imagery followed by technique imagery and energy imagery respectively (Gammage et al. 2000; Hall, Rodgers, Wilson, & Norman, 2010; Milne, Burke, Hall, Nederhof, & Gammage, 2005; Munroe-Chandler, Kim, & Gammage, 2004; Rodgers, Hall, Blanchard, & Munroe, 2001). In a study on two different samples of exercisers, one with aerobics participants and the other with exercisers from different activities, exercise imagery was the imagery type most frequently used. The use of energy imagery differed clearly between the groups. It is possible that this is because of the differences in activity type. The group with aerobics participants used more energy imagery compared to the mixed group.

Based on qualitative research (Giacobbi, Hausenblas, Fallon, & Hall, 2003), another imagery use questionnaire called the Exercise Imagery Inventory (EII; Giacobbi, Hausenblas, & Penfield, 2005) was created. Giacobbi et al. (2003) found that the images of regular exercisers included content which focused on feelings associated with exercise, the exercise context, technique, increased exercise self-efficacy, appearance and health outcomes, beliefs and perceptions about completing workouts.

The EII was developed based on the Giacobbi et al.'s (2003) conclusion that there was a need to measure more exercise imagery types than already measured by the EIQ, such as self-efficacy and health-related images. The EII was later further revised to also include measurement of images related to exercise routines (Giacobbi, Tuccitto, Buman, & Munroe-Chandler, 2010).

One of the most popular models of imagery use is the Applied model of imagery use in sport (Martin, Moritz, & Hall, 1999). Inspired by this model, Munroe-Chandler and Gammage (2005) developed an exercise imagery model consisting of antecedents, imagery functions, imagery outcomes, efficacy beliefs (mediator between imagery and outcomes), and potential moderating factors.

The component antecedents of exercise imagery includes the setting/context of the imagery use, exercise experience, exercise goals and self-presentational concerns. It is proposed that imagery differs with context; for example, exercisers may use imagery to maintain their energy levels and stay focused during a workout, whereas when not exercising, they may use imagery with a focus on exercise goals (e.g., improved appearance) to motivate themselves to attend the next exercise session. Further, it is proposed that more experienced exercisers may use imagery in a different way when compared to less experienced exercisers or sedentary individuals and that the goals exercisers have also influence their exercise images. The exercise imagery used by an exerciser whose goal is to improve a personal best in a marathon will most likely differ from another individual whose motive is to win the local badminton tournament.

The functions in this model are derived from Paivio's (1985) analytic framework for imagery use in sport (i.e., cognitive specific, cognitive general, motivational specific, motivational general-arousal and motivational general-mastery). These functions are explained in more detail under the Revised Applied Model of Deliberate Imagery Use below.

Efficacy expectancy, outcome expectancy, and outcome value are suggested to mediate the relationship between the functions of imagery and its cognitive and behavioural outcomes. By imaging successfully performing a skill, an individual may increase one's confidence in that behaviour (e.g., an exercise routine); imaging running 10 kilometres under 40 minutes may increase one's expectancies to reach that outcome; and imaging certain health outcomes (e.g., lower blood pressure) may help an individual value one's health more.

Several factors are suggested to be moderators of imagery use, including gender, activity type, exercise frequency, imagery ability, age, physical health status and personality. There are a wide variety of different types of physical activities and some of the activities differ quite a lot in their nature (e.g., table-tennis and long distance running). It is therefore natural that the types of images used and how they are used may differ depending on the activity. It is also likely that individuals who exercise seldomly do so for different reasons than individuals who exercise five times a week. Therefore, it is also likely that their imager use will differ.

This model divides exercise imagery outcomes into behavioural and cognitive outcomes. With regard to behaviour outcomes, it is proposed that imagery can increase exercise behaviour and adherence to exercise programmes and help exercisers improve and learn new skills, techniques and routines. With regard to cognitive outcomes, it is suggested that imagery can influence exercise dependence, increase intention/motivation, regulate arousal/anxiety and influence feeling states and body image.

Despite its prominence, this model it has received critique. One of the propositions of the model is that the content and functions of the images are the same. This would for instance mean that images with motivational content should be used for the purposes of increasing motivation. While there is support for the contention that function and content is related (e.g., Mellalieu, Hanton, & Thomas, 2009; Spittle & Kremer, 2010) there is also strong support for the notion that the same image can be used for multiple functions and that it can be used for different functions based on the meaning of the image (e.g., Callow & Waters, 2005; Evans, Jones, & Mullen, 2004; Nordin & Cumming, 2005a, 2008).

Cumming and Williams (2013) expanded on the theoretical underpinnings of the area, building on these previous models, and developed the Revised Applied Model of Deliberate Imagery Use (RAMDIU). A model not only focusing on imagery in sport or exercise, but also rehabilitation and dance.

Revised Applied Model of Deliberate Imagery Use

Guided by new findings and ideas, Cumming and Williams (2012, 2013) revised the previous model and designed it also to suit other domains than sport, such as exercise. The main modifications from the original applied model included separating imagery function from imagery type, and adding personal meaning to bridge function and type. The RAMDIU consists of six components: Where and When (Situation); Who (Individual), Why (Function), What (Type); and How, Imagery Ability, and Outcome. The focus of this model is on deliberate imagery use. Imagery is in general experienced spontaneously frequently during the day and the deliberateness of imagery is normally found somewhere on a continuum between completely spontaneous and completely deliberate (Nordin & Cumming, 2005b;

Nordin, Cumming, Vincent, & McGrory, 2006). The structure of RAMDIU will be used to frame the remaining literature review.

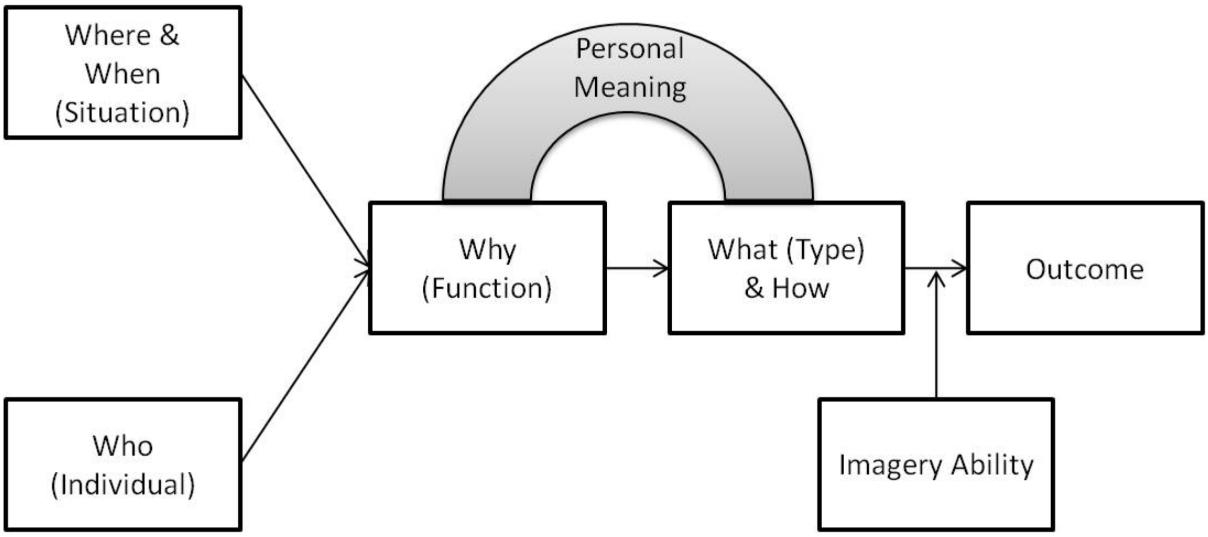


Figure 1.1.

Revised applied model of deliberate imagery use (Cumming & William, 2012)

When and where exercisers image. Exercisers have reported using exercise imagery in different environments, in combination with specific activities and at multiple time points during the day. For example, before, during and after exercise (Giacobbi, Hausenblas, Fallon, & Hall, 2003; Hasenblaus et al. 1999; Kim & Giacobbi, 2009) and, for example, before going to sleep, when waking up/morning, after/while eating, when feeling out of shape and/or when stressed (Hausenblas et al., 1999).

Who. Imagery is a personal experience and the ”Who” component of RAMDIU is used to describe the personal characteristics of the imager and how these affect other components of the model, such as why, what and how imagery is used. Personal factors that have been suggested to be relevant for exercise imagery use are age, gender, physical health status, personality, activity type and exercise behaviour (Munroe-Chandler & Gammage, 2005).

Age. Older adults tend to use imagery with a similar pattern as younger adults (i.e., appearance imagery is used most frequently followed by technique and energy imagery respectively; Milne et al., 2005). However, in a study on exercisers over 65 years of age, the participants reported using appearance and technique imagery to about the same extent, and energy imagery the least (Wesch, Milne, Burke, & Hall, 2006).

Younger adults have reported to use more appearance imagery (Milne et al., 2005) and technique imagery (Giaccobi, 2007; Milne et al., 2005) compared to older adults. Less active young individuals however, have reported using technique imagery more frequently than did their older more active counterparts (Giacobbi, 2007). Thøgersen-Ntoumani et al. (2012) found that older adults' use of energy imagery was directly related to their exercise behaviour while appearance and technique imagery were not.

Based on the results from their study and previous research Thøgersen-Ntoumani et al. (2012) concluded that age functions as a moderating variable. Kalicinski and Lobinger (2013) also supported this notion in their review of benefits of motor and exercise imagery for older adults.

Gender. There have been mixed findings when it comes to the utilisation of imagery and gender differences. There has for example been conflicting results when it comes to energy imagery (Hausenblas, Symons, & Downs, 2002; Gammage et al., 2000). Cumming (2008) and Gammage et al. (2000) found that men reported to use more technique imagery than women, while no differences were found by Hall et al. (2010) and Hausenblas et al. (2002). Women have reported to use appearance imagery (Gammage et al. 2000) and appearance and health imagery to a greater frequency than men (Cumming, 2008) but in the study by Hausenblas et al. (2002), no gender differences were reported. There are different possibilities to explain why there have been mixed findings. Gammage (2000) suggested that gender could have been confounded with activity type in their study and Hall (2010) raised the possibility that their results may have been influenced by the sedentary individuals included in their study sample.

Frequency of exercise behaviour. Both frequent exercisers and sedentary individuals without any intentions to start exercising regularly experience and/or use exercise imagery (Short, Hall, Engel, & Nigg, 2004; Hall et al. 2010). More frequent exercisers tend to use exercise imagery more frequently than less active exercisers (Gammage, Hall, & Martin, 2004; Giacobbi, 2007; Hausenblas, Hall, Rodgers, & Munroe, 1999). Further, Duncan et al. (2012) have shown that imagery use increases in conjunction with increasing exercise behaviour. Sedentary participants have reported experiencing more debilitative images related to exercise than active individuals (Short et al., 2004). These results are all in line with the prediction of the RAMDIU that self-reported activity levels are an antecedent to imagery use. No previous study has however confirmed that exercise behaviour predicts exercise imagery use.

Why exercisers image. The predominant framework for functions of imagery use in sport is Paivio's (1985) analytic framework. It is used in most studies examining athletes' imagery use (for a review, see Cumming & Williams, 2013). This framework has also been adopted to exercise imagery (e.g., Giacobbi, Tuccitto, Buman, & Munroe-Chandler, 2010; Munroe-Chandler & Gammage, 2005). Paivio (1985) proposed two primary functions of imagery, operating at either a general or a specific level, resulting in the following functions of imagery use: cognitive-specific (CS; learning and executing skills); cognitive-general (CG; improving strategies), motivational-specific (MS; e.g., fitness and health outcomes); and motivational general (MG; e.g., improved exercise self-efficacy and stress reduction). Examples of specific reasons reported for using exercise imagery are to improve concentration, motivate to exercise, relieve stress, boost confidence, or feel energized (Kim & Giacobbi, 2009). One exerciser in the study by Kim and Giacobbi explained how imagery helped him boost his confidence:

> I think imagery is a great confidence booster. Especially when lifting weights, you won't accomplish something you've never done before unless you're confident you can do it. I think when you can picture yourself succeeding, your mind gets more comfortable with it and therefore the more you picture it, the more automatic it becomes to you, and that's how it may become a confidence booster (2009, p. 26).

What exercisers image. The component "What" is focused on the imagery content; that is, what the individual images. The use of exercise imagery is usually focused on the exercise activity itself, feelings associated with the activity and appearance and health related images (Hausenblas et al., 1999). Specific content reported by exercisers are images of good mechanics, correct technique, fitting into certain clothes, reducing risk of stroke and heart disease, being more alert and images of looking healthy (Kim & Giacobbi, 2009). The three most frequently reported categories of content reported by aerobic exercise participants in the study by Hausenblas and colleagues (1999) were body image, techniques/strategies and feeling good about oneself and motivation.

How exercisers image "How" is the element of RAMDIU which describes the characteristics of the individuals' imagery experiences and how the imagery can be delivered. Both the content and "how" is represented in the same component of RAMDIU since the characteristics (e.g., senses included, speed) of the image are related to the content. If an individual images running in a forest (content), the image may be experienced only visually from an outside perspective in slow motion (characteristics) or the individual may have included visual images (of the path, the trees etc.), kinaesthetic images of the legs and arms working, tactile feelings of the feet on the ground, and sounds from breathing and bird song from the trees, from an internal visual perspective and in real time. These two images are normally categorised to have the same imagery content but since they differ so much in how the characteristics are included, it also could be argued that they differ in terms of content.

When imaging one includes the experiences from of one or several of the senses (e.g., visual and kinaesthetic images) as well as emotions. Many studies have focused on different modalities in sport but, in exercise, different sensory modalities have only been mentioned in a few studies (e.g., Kim & Giacobbi, 2009). In the study by Kim and Giacobbi, the perspectives used were also reported. Out of the 30 participants, 16 reported using exercise imagery from an internal perspective, nine from an external, and five reported using both. Research has looked at exercise imagery and emotions (Giacobbi, Hausenblas, Fallon, & Hall, 2003), but no studies have examined other characteristics in the exercise setting, such as speed of imagery, angle and agency.

Outcomes of exercise imagery Four main types of imagery outcomes are represented in the final component of RAMDIU: 1) psychological outcomes; 2) injury rehabilitation; 3) motor learning and performance; 4) strategies and problem-solving (Guillot & Collett, 2008); and health-related goals (Giacobbi, et al., 2003; Schuster, et al., 2012). The present thesis focuses on psychological outcomes and health-related goals, such as a greater intention to be more active and increase exercise behaviour.

Imagery can be used to evoke positive and negative emotions (Holmes, Mathews, & Dalgleish, 2008) and exercisers image themselves experiencing positive emotions (Giacobbi et al., 2003) and enjoying exercise (Kim & Giacobbi, 2009). Increased enjoyment and energy can also be experienced as a result of their imagery use (Kim & Giacobbi, 2009). Research has demonstrated that different types of imagery can be used to influence the individual's affective states, more specifically enjoyment, energy, and technique imagery (Stanley & Cumming, 2010a, 2010b).

Exercisers report using imagery to alter their feeling states (Giacobbi et al., 2003; Hausenblas et al., 1999; Short et al., 2004). Specific affective states relevant for exercise adherence is exercise induced feeling states (Annesi, 2002a, 2002b). Feeling states are defined as “those human experiences that include bodily reactions, cognitive appraisals, actual or potential instrumental responses, or some combination thereof” (Gauvin & Spence, 1998, p. 326).

An explanation as to why imagery can be used to influence feeling states is found in the bio-informational theory (Lang, 1979). The theory proposes that an image is "a finite information structure which can be reduced to specific propositional units" (1979b, p. 109). The images may contain information about the stimulus (e.g., the exerciser is running) and information about the response to this activity (e.g., increased heart rate, heavier respiration). This information is stored in the long-term memory. Images containing this information can also produce a physiological response in terms of, for example, increased anxiety levels and heart rate (Cumming, Olphin, & Law (2007).

The anecdotal evidence and theoretical explanations of the influence of imagery on feeling states are supported by experimental research. In an experiment by Stanley and Cumming (2010a), enjoyment and energy imagery increased valence. In another study by the same authors (2010b), the use of enjoyment imagery brought about significantly higher levels of valence than the energy and technique imagery, and significantly higher levels of revitalization compared to technique imagery.

A technique Bandura proposed can be used to increase self-efficacy is imagery (1986, 1997). Social cognitive theory (Bandura, 1977, 1986) is one of the most prominent theories when examining the underlying mechanisms to physical activity outcomes. An addition to the social cognitive theory is self-efficacy theory (Bandura, 2006). Self-efficacy is the "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3; Bandura, 1997). Efficacy cognitions influence individuals' emotional reactions, goals, self-regulation, and thoughts patterns, as well as behaviour in terms of choices, effort and persistence (Short & Ross-Stewart, 2006). Self-efficacy predicts both adoption and maintenance of physical activity (Sallis, Haskell, Fortmann, Vranizan, & Solomon, 1986) McAuley, Lox, & Duncan, 1993). There are different types of self-efficacy and the most common types discussed in relation to physical activity are coping/barrier, task and scheduling self-efficacy. Inherent in physical activity is the experience of effort and pain. A general perception of physical activity is that it is tough and time consuming and therefore there are also many barriers associated with it. The belief an individual has in their ability to deal with these barriers and continue with the exercise regime has shown to be important for continued exercise behaviour.

Bandura (1997) suggested that four main sources influence individual's self-efficacy beliefs: Mastery experiences (i.e., successful past performances); Vicarious experience (i.e., modelled behaviour, observing someone else's successful actions in a related task to the one being considered); Social persuasion (i.e., feedback, appraisals and judgments from others about involvement in related tasks); and physiological responses (i.e., emotions and sensations, like anxiety, arousal, fatigue, experienced while performing a similar task). There is considerable support for these sources in different domains (Bandura, 1997; Lee, Avis, & Arthur 2007a, 2007b, Moritz, Feltz, Fahrbach, & Mach, 2000; Prapavessis & Grove, 1994; Treasure, Monson, & Lox, 1996).

The use of imagery can tap several of the sources of self-efficacy. Imagery is used to increase self-efficacy in a number of different domains, such as sports, rehabilitation, and business management. It is also used by individuals to increase exercise self-efficacy in both sedentary (Hall, Rodgers, Wilson, & Norman, 2010) and active individuals (Short, Hall, Engel, & Nigg 2004).

In spite of Hall's proposal in 1995 and research evidence in both sport (e.g., Callow & Waters, 2005) and exercise (e.g., Cumming, 2008), only two interventions have been carried out so far with the explicit aim to increase exercise self-efficacy. In the study by Andersson and Moss (2010), there were no effect on self-efficacy. In the study by Duncan et al. (2011) task, coping, and scheduling self-efficacy was successfully increased.

It is a complex research area involving different types of self-efficacy evolving at different rates and at different stages of the exercise stages of change. Different sources of self-efficacy also exist and they affect individuals in different ways. Further, there are different types of exercise imagery and imagery could be implemented in many different ways. There is a clear need for more exercise imagery interventions. Not only because of a clear lack of intervention studies carried out but mostly because there is a need to examine and test how imagery can be implemented in the best way, when and for how long it is necessary to rehearse. Since adherence to exercise programs is a challenge, it is valuable to find ways to improve barrier self-efficacy effectively. Therefore, there is a need for short interventions.

Imagery ability and its assessment

RAMDIU proposes that imagery ability both mediates and moderates the relationship between imagery use and its outcomes. Imagery ability has been defined as "an individual's capability of forming vivid, controllable images and retaining them for sufficient time to affect the desired imagery rehearsal" (Morris, Spittle, & Watt, 2005, p. 37).

The imagery process includes generation, maintenance, inspection, and transformation of an image (Kosslyn, 1994). Imagery ability can be divided into different dimensions and these dimensions involve the ability to perform one or several of the different skills in the imagery process. Three especially important dimensions of imagery ability are ease of imaging, controllability, and vividness (Cumming & Williams, 2013; Watt, Morris, & Andersen, 2004).

Ease of imaging refers to how much effort it takes for an individual to create and control an image, while vividness denotes its clarity, sharpness or sensory richness (Anuar, Cumming, & Williams, 2015; Baddeley & Andrade, 2000; Hall & Martin, 1997). Controllability refers to the ability an individual has to influence the imagery content (Murphy, 1994). It includes, for example, how accurately an image can be transformed or manipulated (Moran, 1993), as well as refreshing and maintaining the image (Denis, 1985).

Like with any skill, better imagery ability will likely result in better outcomes (Robin et al., 2007). In a study on 162 exercisers between the ages of 18 and 66 years, Cumming (2008) found that exercise imagery ability moderates the relationship between imagery use and certain outcomes (Cumming, 2008). More specifically, imagery ability moderated the relationship between appearance-health images and leisure-time exercise, coping efficacy, and scheduling efficacy. Further, males found it easier to image technique images compared to females.

Several imagery ability measures are used in the sport domain (e.g., the SIAQ; Williams & Cumming, 2011), but currently no measure has been specifically developed to measure exercise imagery. Instead, other ways of measuring the construct have been used, such as single items and an ease of imaging companion scale. In three studies (Cumming, 2008; Stanley & Cumming, 2010a; Stanley & Cumming, 2010b) an ease of imaging companion scale has been added to the EII or EIQ to assess exercise imagery ability. The internal reliability with this added scale has been found to be more than adequate (e.g., Cumming, 2008). This is an improvement on using only a few single items. The ease of imaging scale is combined with vigorously tested imagery use items and the imagery ability results could be compared to imagery use results. There is still a need for a more comprehensive measure. Further, ease of imaging represents only one dimension of imagery ability.

Several studies on sport imagery have demonstrated that it is possible to improve imagery ability (e.g., Cumming & Ste-Marie, 2001). Research has also showed that different types, dimensions and modalities can be improved at different rates and with varied success (e.g., Williams et al., 2013; Rodgers, Hall, & Buckholz, 1991). These investigations should be extended to the exercise imagery domain to learn more about imagery ability and more specifically about exercise imagery ability. To be able to carry out successful imagery interventions there is a need to know if certain imagery types or modalities require more or less imagery training, if this training needs to specific, and in that case, to learn more about the nature of this training.

Only one intervention study to increase exercise imagery ability has been carried out. It was an intervention study on inactive individuals to promote physical activity. Chan and Cameron (2012) used three subscales, each including three items, to assess how vividly the participants could image three different imagery types used in the study. The results showed that the participants improved their ability to image the imagery content included in their imagery rehearsal. This is only a single study though, and no psychometric properties were reported. However, it indicated that exercise imagery ability can be increased.

So far, only two dimensions of imagery ability have been assessed in exercise imagery research; vividness and ease of imaging. No exercise research study has tested if it is possible to improve the ease of imaging exercise content. The studies assessing ease of imaging have only done so to control for it. However, Williams et al. (2013) found that it is possible to improve sport imagery ease of imaging both through rehearsal and Layered Stimulus Response Training (LSRT).

One important exercise imagery dimension that has not been investigated or measured is imagery control. Imagery can be either facilitative or debilitative (Nordin & Cumming, 2005a) and if the individual is unable to control the imagery content, it is possible the desired images are replaced by debilitative images. An individual who wants to start to exercise more regularly may motivate herself by imaging going for a swim in the local swimming pool, she may start imaging how good it feels to swim in the water and that she feels strong and healthy. Suddenly, she may lose control over her imagery and instead images how cold and tired she feels when swimming and how she experiences trouble breathing. The image went from being facilitative to debilitative because she could not control it. When carrying out a guided imagery program, it is important to know that the individuals can generate the images but also control them and hence image what is intended. To learn more about exercise imagery control and how to best train this dimension, it is necessary to measure it and include the dimension in imagery interventions. Initially, it is important to test if it is possible to control exercise images and if it is possible to improve this ability through only a brief intervention.

There seems to be a general understanding that the way to improve imagery ability is through rehearsal, that is to simply use more imagery. As with most skills, it is possible to improve imagery through practice but it is also of great importance how this practice is carried out. Despite being such a popular and effective technique, very few recognised methods for improving imagery ability exist (Cumming, et al., 2016).

In order to meet the need for an effective and practical method, Cumming and Williams (2013) developed LSRT (see Figure 1.2). LSRT is based on bioinformational theory (Lang, 1977) and response training (Lang, Kozak, Miller, Levin, & McLean, 1980).

Research on golf putting has showed LSRT can improve both task specific and general visual and kinaesthetic imagery and that LSRT lead to more improvements than rehearsal alone (Williams et al., 2013). LSRT is a technique, usually guided by a practitioner, with which the participant is able to work with an image and develop it further. Through this process, it is possible to improve the general ability to generate and control images (Williams et al., 2013). The LSRT working process is cyclical, with series of imaging, reflection, and the development of new layers. Each layer may contain stimulus, response and meaning propositions. The aim during the process is to combine these propositions so that the image becomes effective and meaningful. The participant images a specific scenario and assesses how well it was imaged by using simple rating scales. The image is broken down into a single layer (e.g., focusing on visual information). The image is then gradually re-built layer by layer, by reflecting on the past image, deciding on what to add to the image (the next layer, e.g., focusing on kinaesthetic information). This is followed by reflection and so on. LSRT has never been used in an exercise context before.

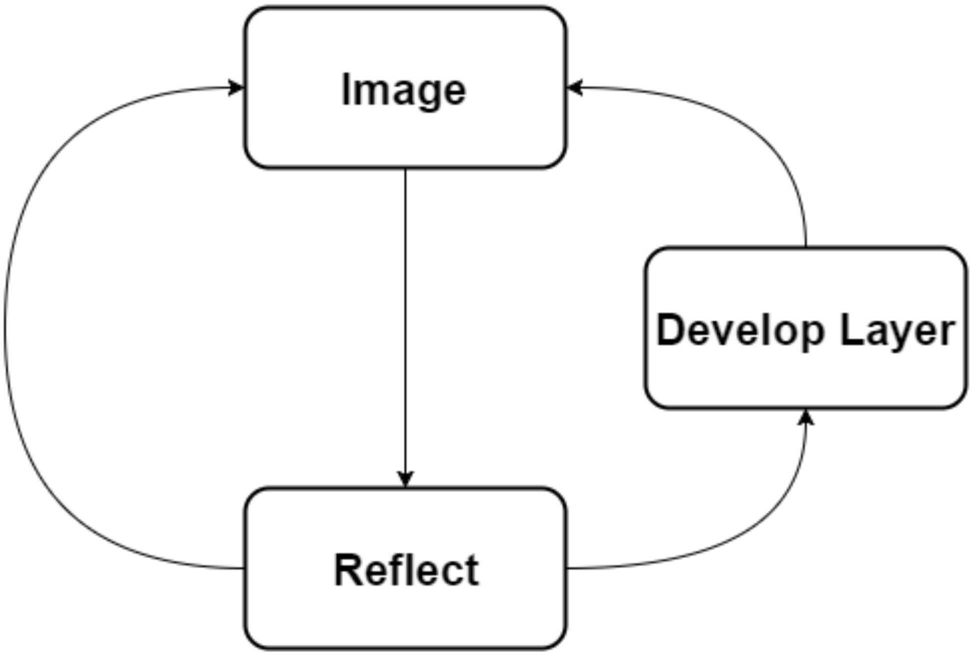


Figure 1.2.

Process of layered stimulus response training (LSRT; Cumming et al., 2016).

Summary and Rationale for Research Program

Sedentary behaviour continues to be a global health problem and there is a need to improve exercise adherence. Exercise imagery is a promising technique to address this problem, but in order to improve the implementation of this technique, more research is needed, both theoretical and practical. A good model to guide this work is the RAMDIU.

Important factors influencing continued participation in exercise programs are an individual's belief in the ability to maintain exercise routines in the face of repetitive and challenging barriers, and affective responses to exercise that keeps the activity rewarding and enjoyable. Research has demonstrated that imagery can be used to increase self-efficacy in sport and, to some extent, in the exercise domain. The results have however been mixed when it comes to exercise imagery, so there is a need to further examine what the best strategy is to use and how much training that is needed.

Even though imagery ability is crucial for the success of imagery interventions the area of exercise imagery research is greatly underdeveloped. Only one study has previously showed that it is possible to increase exercise imagery (Chan & Cameron, 2012). However, they carried out a relatively long intervention, only used imagery rehearsal and focused only on one imagery dimension.

Individuals who exercise less and are in the need of tools, techniques and strategies to keep exercising are unfortunately in general also less good at using exercise imagery. Therefore, it is important to develop strategies to improve imagery ability among insufficiently active individuals, other than simple imagery rehearsal. LSRT has been implemented successfully in the sport domain but has not been tested in the exercise domain. It is also imperative to investigate if other important exercise imagery dimensions like ease of imaging and imagery control can be improved, and if it is possible to improve exercise imagery ability with a brief intervention.

Outline of Research Program

The aim of this thesis was to examine tenets of the revised applied model of deliberate imagery use (Cumming & Williams, 2013) in an exercise context.

The aim of the first study (Chapter 2) was to examine if a short (i.e., one week) period of imagery rehearsal could increase barrier self-efficacy in women. To test this idea, a brief imagery intervention with women who wanted to increase their exercise behaviour was conducted. It was hypothesized that a group randomly assigned to rehearsing an imagery script daily for one week would significantly increase their barrier self-efficacy while the control group would not.

The aim of the second study (Chapter 3) was to investigate if the feasibility of combining LSRT with one week of guided rehearsal to improve imagery ability among women who want to exercise more. This group (receiving LSRT and rehearsal) was compared to a group which received LSRT but no rehearsal (i.e., control group). A second study aim of the second study was to investigate if there were changes in these variables from pre-intervention to post-intervention and to determine if increased imagery ability at post-intervention was associated with better exercise-related outcomes. It is important to note that the data used in both chapter 2 and chapter 3 were taken from the same imagery intervention.

Chapter 2

Walk this way: A brief exercise imagery intervention increases barrier self-efficacy in women

This study has been published under the following reference:

Weibull, F., Cumming, J., Cooley, S. J., Williams, S. E., & Burns, V. E. (2014). Walk this way: A brief exercise imagery intervention increases barrier self-efficacy in women. *Current Psychology*, *34*, 477-490. doi: 10.1007/s12144-014-9271-0

Introduction

Even though there is overwhelming evidence for the many health benefits associated with physical activity (for a review see Warburton, Nicol, & Bredin, 2006), sedentary behaviour continues to be a major public health problem (Blair, 2009). The World Health Organization (WHO, 2010) recommends that adults should engage in at least 30 minutes of moderate exercise 5 days per week to optimize physical and mental health. Despite this advice, many women are not sufficiently active putting them at significant risk for coronary heart disease, cancer, type II diabetes, obesity, osteoporosis, and pre-mature death (Morseth, Emaus, Wilsgarrd, Jacobsen, & Jørgensen, 2010; Proper, Singh, van Mechelen, & Chinapaw, 2011; Thorp, Owen, Neuhaus, & Dunstan, 2011). In the Health Survey for England 2012 commissioned by the Health and Social Care Information Centre (2013) it was reported that among adults aged 16 and over only 32 percent of women, compared to 43 percent of men, met the recommended levels of exercise. Further, at all ages women are less physically active than men (Talbot, Metter, & Fleg, 2000). Given the major risks involved with inactivity, there is clearly a crucial need for women to become more active (Nies & Sun, 2008).

If strategies to increase physical activity are to be successful long term, it is important to acknowledge the barriers women face in attempting to be more active (Lovell, El Ansari, & Parker, 2010). Self-efficacy theory (Bandura, 1986, 1997) can be applied as a way to augment beliefs in one's ability to overcome barriers such as time and fatigue. Bandura (1997) defined self-efficacy as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (p. 3). Barrier self-efficacy is a specific type of efficacy beliefs concerning one’s capabilities to overcome barriers to exercise (McAuley, 1992). The strength of these beliefs is closely related to an individual’s persistence and efforts towards a specific behaviour (Bandura, 1997). If an individual has strong beliefs in her capability to perform a set of actions despite constraints or impediments, she will more likely initiate and persist at exercise. For example, individuals with high levels of self-efficacy for exercise behaviour tend to be more physically active (e.g., Rodgers & Sullivan, 2001). Furthermore, a lack of confidence can in and of itself be considered a barrier to exercise (Withall, Jago, & Fox, 2011).

Self-efficacy beliefs are not only a key determinant of exercise behaviour but can also be used as a mechanism for increasing physical activity levels (Lee, Arthur, & Avis, 2008; McAuley & Blissmer, 2000). In a community-based walking intervention among hypertensive older individuals, the four information sources of self-efficacy proposed by Bandura (1997) were provided by a public health nurse (Lee, Avis, & Arthur, 2007a, 2007b). These included identifying participants' achievements in regular walking (*performance accomplishments*), reinforcing successful and enjoyable walking experiences (*vicarious learning*), providing verbal support (*verbal encouragement*), and helping participants to recognize positive feelings from walking (*physiological and emotional response towards an activity*). After 6 months, participants reported greater exercise self-efficacy, reductions in systolic blood pressure, and walked more regularly.

Despite this promising evidence, there is large variability in the types and effectiveness of intervention techniques used to increase exercise self-efficacy. A recent meta-analysis showed only a small but significant overall effect of interventions to increase exercise self-efficacy (d = 0.16, $p < .001$; Ashford, Edmunds, & French, 2010). Amongst the techniques compared, exercise self-efficacy was significantly higher when vicarious experiences were included in the intervention. Vicarious experiences typically involves watching a similar other carry out the behaviour, either in real life or on videotape. These observations are thought to raise an individual's belief that they too possess the necessary capabilities to execute the behaviour (Bandura, 1997).

Another form of vicarious experience is mentally imaging oneself performing the behaviour. It is notable, however, that imagery can also involve experiencing a sense of accomplishment and the positive physiological and emotional responses associated with the behaviour (Cumming, Olphin, & Law, 2007; Williams, Cumming, & Balanos, 2010). As a consequence of tapping these multiple sources simultaneously, imagery has the potential for being an effective technique for bolstering self-efficacy beliefs. Indeed, Bandura (1997) explains that combining different sources of self-efficacy will have an additive effect by complementing each other on the information provided; a proposal that has also received empirical support (Wise & Trunnell, 2001). Wise and Trunnell found that the strength of the participants' bench-press self-efficacy was greatest when given three different sources of self-efficacy information (performance accomplishments, vicarious learning and verbal encouragement). The same sources, along with physiological and emotional responses, could be included in a single imagery script to bolster self-efficacy.

Research demonstrates that imagery can increase self-efficacy in different contexts, including rehabilitation (e.g., Menzies, Taylor, & Bourguignon, 2006) and sport (e.g., Callow, Hardy, & Hall, 2001), but is only just beginning to tap its potential for increasing exercise behaviour (Giacobbi, Hausenblas, & Penfield, 2005). A positive relationship exists between exercisers' use of imagery and their levels of exercise self-efficacy (Cumming, 2008; Wesch et al., 2006). Exercisers report using imagery to increase self-confidence (Short, Hall, Engel, & Nigg, 2004) and sedentary people also report experiencing exercise-related images (Hall, Rodgers, Wilson, & Norman, 2010) suggesting that imagery could be an appropriate intervention strategy for increasing self-efficacy in both active and insufficiently active women.

To date, very few imagery interventions have been carried out with the specific aim to increase self-efficacy in relation to exercise. Two recent studies have provided guided imagery scripts to participants who did not regularly exercise and produced mixed results (Andersson & Moss, 2011; Duncan, Rodgers, Hall, & Wilson, 2011). Andersson and Moss found no significant increases in self-efficacy for participants who listened to an imagery script on a daily basis. Anderson and Moss speculated that the script did not include enough self-efficacy related images to affect the participants' self-efficacy. Another intervention carried out by Duncan et al. (2011) attempted to determine if different types of self-efficacy (i.e., task, coping,[1] or scheduling) are differentially influenced by a guided imagery intervention. Significant increases in all three types of self-efficacy were found after six weeks of imagery training carried out alongside an exercise program. There was also a significantly larger increase of the type of self-efficacy that was targeted with the imagery intervention for each group compared to the other types. As Duncan et al. only measured self-efficacy before and after the intervention, it is impossible to determine when improvements to self-efficacy occurred. It is likely that the impact of imagery was more immediate and self-efficacy improvements may have occurred earlier than 6 weeks. It is important to determine if shorter interventions could increase the likelihood of adherence to inform eventual guidelines on the optimal length of imagery interventions.

To examine whether imagery can increase barrier self-efficacy more immediately, and to build on previous research, the aim of the present study was to examine if a short (i.e., one week) period of imagery rehearsal could increase barrier self-efficacy in women. To test this idea, we carried out a brief imagery intervention with women who wanted to increase their

[1] Coping self-efficacy, and its subtype of scheduling self-efficacy, is conceptually similar to barrier self-efficacy (Rodgers & Sullivan, 2001; Ross-Stewart, Short & Terrance, 2010), and the two terms have been used interchangeably. To avoid confusion, the present study adopts the term barrier self-efficacy.

exercise behaviour. Brisk walking was chosen as the type of exercise to image because it is an activity that is freely available to most people and can have clinically meaningful improvements in cardiorespiratory fitness (Anton, Duncan, Limacher, Martin, & Perri, 2011). However, perceived barriers to walking exist including a lack of energy and feelings of worry that discomfort will be experienced (McAuley, Poag, Gleason, & Wraith, 1990).

Based on previous research demonstrating that greater imagery use is associated with higher levels of exercise self-efficacy (Cumming, 2008; Wesch et al., 2006), we hypothesized that a group randomly assigned to rehearsing an imagery script daily for one week would significantly increase their barrier self-efficacy while the control group would not.

Method

Participants

As part of a larger study, 32 women between the ages of 20 and 50 years (M = 31.90; SD = 10.17) participated in the intervention. The majority of participants were white (n=28), except four individuals who indicated their ethnicity as black (n = 2) or of mixed origin (n = 2). All the participants were recruited on the basis that they wanted to increase their exercise behaviour. The mean body mass index (BMI) for the sample was 26.93 (SD = 7.11) with 46.88 % of the participants being either overweight or obese. The majority of participants (n = 20) did not meet the physical activity guidelines outlined by the WHO (2010). The average energy expenditure of the entire sample in a typical week was a metabolic equivalent (MET) of 20.75 (SD = 20.57; values ranged between 0 and 80), where a MET value of 25 reflects moderate exercise (WHO, 2010). Six participants reported engaging in regular exercise (i.e., that is, planned physical activity performed to increase physical fitness of a vigorous or moderate intensity). However, only three of these participants reported MET values that were equivalent to meeting the WHO guidelines. Also, there was no significant difference in MET between the six participants who reported to engage in regular exercise compared with the rest of the sample. The main forms of physical activity reported were walking (n = 17), running/jogging (n = 5), aerobics/dance (n = 4), and using cardio training/gym machines (n = 2). The remaining four participants reported swimming, cycling, team sports, and yoga/pilates as their primary exercise activity.

Measures

Demographic information. The participants were asked to provide information on their age, gender, weight, height, and primary exercise activity.

Physical activity levels. The Godin Leisure-Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985) was used to assess participants' self-report exercise behaviour by asking them how frequently they undertake more than 20 minutes of mild (e.g., bowling), moderate (e.g., fast walking), and strenuous (e.g., running) exercise during their free time in a typical week. A metabolic equivalent (MET) score was calculated by placing the participants' responses in the following equation: (strenuous x 9) + (moderate x 5) + (mild x 3). The LTEQ has been tested on both men and women, aged 20-59, with varying physical activity levels and has been shown to be both valid and reliable (e.g., Jacobs, Ainsworth, Hartman, & Leon, 1993).

Barriers self-efficacy. The Barriers Self-efficacy Scale (BARSE; McAuley, 1992) is an exercise-specific self-efficacy measure used to assess perceived capability to exercise in the face of barriers to participation. Participants rate their confidence on a 10-point scale (1 = *no confidence at all*; 10 = *completely confident*) for 12 barriers such as "I had to exercise alone", "I was under personal stress of some kind" and "I was on vacation". Research has supported both its reliability and validity (McAuley, 1992; McAuley, Jerome, Marquez, Elavsky, & Blissmer, 2003; Giacobbi et al., 2005).

Exercise imagery ability. To screen participants for their ability to generate exercise-related images, a modified version of the Exercise Imagery Questionnaire (EIQ; Hausenblas, Hall, Rodgers, & Munroe, 1999) used by Stanley and Cumming (2010a) was employed. This measure includes the original 9 items to measure appearance, technique, and energy imagery (3 items/subscale), and the three items to assess enjoyment imagery that were added by Stanley and Cumming (2010a). Examples of items are "When I think about exercise, I imagine myself having fun while exercising." and "When I think about exercising, I imagine my form and body position". The items have been used on men and women with varying exercise levels, ages and with experience from a wide variety of different exercise activities. All items have been reported to have adequate psychometric properties and good internal reliability (e.g., Stanley & Cumming, 2010a; Gammage, Hall, & Rodgers, 2000). Each item is rated on a 7-point Likert-type ease of imaging rating scale with scores ranging from 1 (*very hard to image*) to 7 (*very easy to image*) (Cumming, 2008). There is a lack of valid and reliable questionnaires of exercise imagery ability (Cumming, 2008) and the EIQ with an added ease of imaging scale has been used successfully and demonstrates good psychometric properties (Stanley & Cumming, 2010a). For the purposes of the present study, a general ease of imagery score was created by averaging scores across the four subscales. All of the subscales also correlate significantly ($p < .05$) with each other ($r = .48.82$) except for the correlation between appearance and enjoyment.

Post imagery trial ratings. Following each imagery trial during two separate lab visits, participants rated their ability to image the scripts with the following item: "How easy was it for you to create the images described in the scenario?". Ratings were made on a 7-point Likert scale (1 = *very hard*; 7 = *very easy*). The participants rated the direction of their images (i.e., how hurtful/helpful they were). Ratings were made on a 7-point Likert scale (1 = *very hurtful*; 7 = *very helpful*).

Imagery diary. A diary was used to monitor daily imagery rehearsal for participants assigned to the rehearsal group. They were asked to rate their ease of imaging the script using the post imagery trial rating.

Procedures

After ethical approval was obtained, eligible individuals were recruited using a variety of strategies (e.g., posters, emails, word-of-mouth). The study consisted of two visits to the lab 7 days (+/- 1 day) apart.

Visit 1. Prospective participants were provided with information about the study, and then gave consent for their involvement. They completed a multi-section questionnaire to obtain demographic information and measures of physical activity, barriers self-efficacy, and imagery ability.

Participants then listened to an imagery script played via headphones on a Packard Bell FunKey Neo MP3 player. During the first imagery trial, the participants listened to pre-recorded instructions, in which they were asked to image as vividly, clear and detailed as possible, and to make the experience personalized for them by deciding on details about the exercise environment where they would take their imaged walk. The instructions (i.e., information on what they will do and what to think about during, for example "While listening to the script, I would also like you to make the experience personalised for you" and "To make the images clear and vivid, you should include your emotions and use as many relevant senses as possible in your imagery.") lasted 1 minute and 7 seconds and were immediately followed by the 4 min 10 s long imagery script.

The response-based script was designed based on bioinformational theory (Lang, 1979; Lang, Kozak, Miller, Levin, & McLean, 1980) and previous research (e.g., Stanley & Cumming, 2010b) and tapped different sources of self-efficacy (Bandura, 1997). For example, imagining "You are really proud of what you accomplished on today's walk and happy with the effort you made" which is aimed to elicit a sense of accomplishment. The image "You enjoy feeling them (the arms) work hard as you vigorously walk" which aimed to evoke positive physiological and emotional responses associated with the walking. The wording of the script was initially pilot tested with 5 undergraduate students, and revisions were made based on their feedback.

After listening to the audio imagery script, participants rated their ease of imaging. To improve their ability to image script content, participants then took part in imagery training called layered stimulus and response training (LSRT) based on previous research (e.g., Williams, Cooley, & Cumming, 2013). Training made participants more aware of stimulus (i.e. information concerning the stimuli in the environment including multi-sensory information), response (i.e. the cognitive, behavioural and affective responses of an individual to given stimulus in an environment), and meaning propositions (i.e. how meaningful the response propositions are in relation to the stimulus propositions and the perceived importance of the imagined scene to the individual) by starting with a simple image of themselves walking, and incorporating additional details in subsequent layers (e.g., how their body responded to the exercise, what emotions they experienced). A second imagery trial followed the training. This trial was identical to the first one, including the instructions, script, and rating of ease of imagery.

At the end of Visit 1, participants were randomly assigned to one of two experimental conditions (control group = 15; rehearsal group = 17). Participants in the rehearsal group received an MP3 player with two audio files uploaded, the instructions and the imagery script. They were asked to image the script once a day for a week. They were also given a diary to record information about their imagery sessions. Text message prompts were sent daily as reminders to the participants. The control group was just asked to return the following week.

Visit 2. The MP3 player and the diary were collected at the beginning of the second visit from participants in the rehearsal group. Two imagery trials were again carried out including instructions, imagery script, and rating of ease of imagery. Unlike Visit 1, however, participants did not receive LSRT between the first and second imagery trial. After the second imagery trial, participants again completed the measure of barriers self-efficacy. All participants were then thanked and received information pamphlets to support their exercise behaviour and imagery use. They also received a recording of the imagery script for their personal use.

Results

Preliminary analysis

Two participants (one from each group) were excluded from the data analysis because they did not attend the second visit, leaving a final sample size of 32 (rehearsal = 17, control = 15).

Imagery ability. An independent samples t-tests revealed no significant difference between the rehearsal group (M = 3.63, SD = 1.24) and the control group (M = 2.95, SD = 1.37) on their exercise imagery ability prior to the study, $t(30) = 1.49$, $p = .147$.

To examine differences in how easily participants imaged the script, a 2 group (rehearsal, control) x 4 time (2 imagery trials on each of 2 visits) mixed design repeated measures ANOVA was carried out. Mauchly's test of sphericity revealed violation to this assumption ($p < .05$). For this analysis and subsequent ones when the test was significant, the Greenhouse–Geisser correction is reported. There was no significant effect for group and no time by group interaction indicating that groups did not differ in their ability to image the scripts over time. There was however a significant main effect for time, $F(2.34, 67.92) = 8.47$, $p < .001$, $\eta_p^2 = .226$; a follow-up post hoc test (Bonferroni) indicate that both groups improved their ease of imaging the script from the first to second imagery trial during Visit 1, with no further improvements found for the Visit 2 trials. The means and standard deviations of the participants' ease of imaging scores during the four imagery trials are presented in Table 2.1.

Table 2.1

Ease of imaging during Visit 1 and 2 (n = 31)

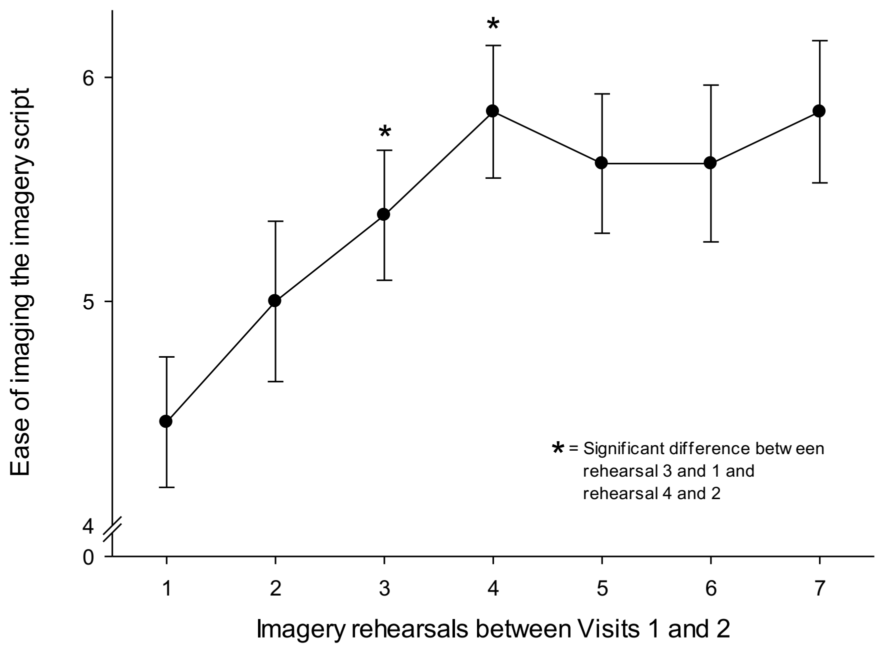
Imagery trials	*M*	*SD*	Mean differences with trial 1
1	4.55	1.34	
2	5.32	1.08	0.77*
3	5.45	1.21	0.90*
4	5.48	1.12	0.93*

* p < .05

Imagery diary. Thirteen participants in the rehearsal group rehearsed the imagery script 7 times (everyday) as instructed whereas two participants rehearsed the script six times, one rehearsed it five times and one rehearsed it four times. Ratings were given in the diary for ease of imaging the script each time it was rehearsed. A repeated measures ANOVA was conducted to investigate the ease of imaging the script during the imagery rehearsals. As Mauchly's test of sphericity indicated further violations of assumptions ($p < .05$), the Greenhouse–Geisser correction was again reported. There was a significant main effect for time for the ease of imaging the script, $F(3.05, 36.58) = 6.27$, $p = .001$, $\eta_p^2 = .34$; a follow-up Bonferroni post hoc test indicated participants in the rehearsal group significantly improved their ease of imaging between rehearsal 1 and 3, and 4 and 2 and then experienced a plateau between rehearsals 4 and 7. Each means and standard deviations of the participants' ease of imaging scores during each imagery rehearsal are presented in Figure 2.1.

Figure 2.1.

Ease of imaging the imagery script for the rehearsal group (n = 13) during the rehearsal of the script between Visit 1 and Visit 2.



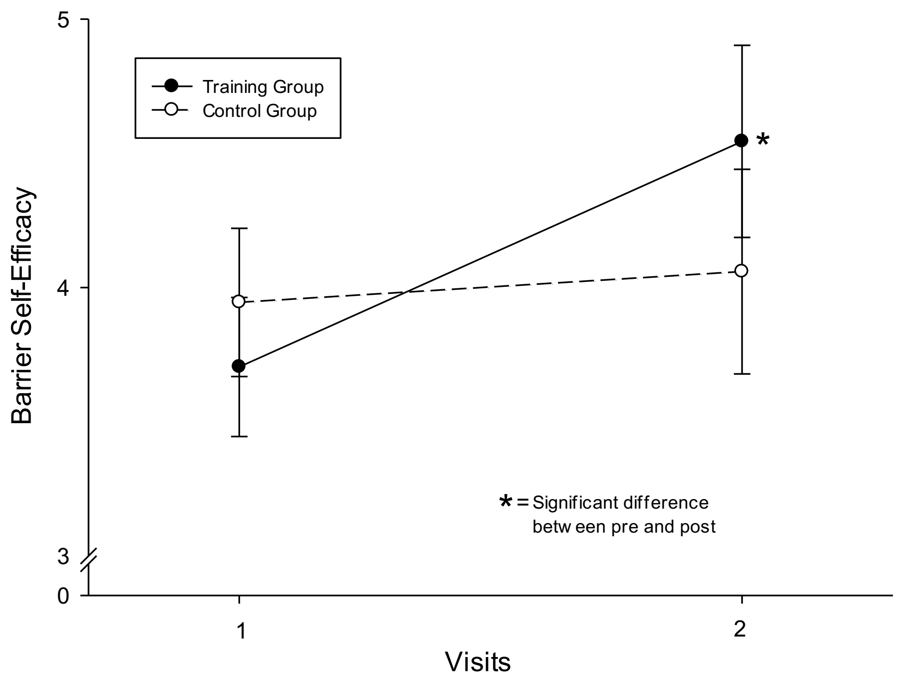
Note. The error bars represent the error values.

Main analysis x 4 time (2 imagery trials on each of 2 visits)

A 2 group (rehearsal, control) x 2 time (visit 1, visit 2) mixed design repeated measures ANOVA was conducted to investigate if there was a difference in barrier self-efficacy between Visit 1 and 2 for the control and rehearsal groups. A significant main effect was found for time, F(1, 30) = 8.159, $p = .008$, $\eta_p^2 = .214$. There was also a significant time by group interaction, $F(1, 30) = 4.71$, $p = .038$, $\eta_p^2 = .136$, in which the rehearsal group improved their barrier self-efficacy from Visit 1 to 2, while there were no improvement for the control group. The means and standard deviations of both groups' barrier self-efficacy at Visit 1 and 2 are presented in Figure 2.2 and Table 2.2.

Figure 2.2

Barrier self-efficacy for the control group (n = 17) and the rehearsal group (n = 15) at Visit 1 and Visit 2



Note. The error bars represent the error values.

Table 2.2

Barrier self-efficacy for the control group (n = 17) and the rehearsal group (n = 15) at Visit 1 and Visit 2.

Groups	*Visits*	*M*	*SD*
Control group	1	3.94	1.00
	2	4.06	1.44
Rehearal group	1	3.70	1.12
	2	4.54	1.51

Although participants were randomly assigned to groups (and therefore had the same chance of receiving rehearsal or control as a condition), there was some variability apparent in the pre-study exercise behaviour (i.e., MET scores from the LTEQ). An independent samples t-test with equal variances not assumed (the Levene's test of equality of variance was significant, therefore equal variances not assumed was used to interpret the t-test) confirmed that these differences between the rehearsal group (M = 27.35, SD = 24.42) and the control group (M = 13.27, SD = 11.93) were significant, $t(23.83) = 2.11$, p = . 046. Therefore, a 2 group (rehearsal, control) x 2 time (Visit 1, Visit 2) mixed designs repeated measures ANCOVA, with pre-intervention MET as a covariate, was conducted to investigate differences in barrier self-efficacy. After controlling for pre-study exercise behaviour, the main effect for time was no longer significant and neither was the time by group interaction, $F(1, 29) = 1.81$, $p = .189$, $\eta_p^2 = .059$.

Discussion

The purpose of the present study was to determine whether a brief intervention of imagery rehearsal increases barrier self-efficacy among a group of women who had stated a desire to exercise more. Aligned with our prediction, the results are the first to show that one week of daily imagery rehearsal led to greater increases in barrier self-efficacy compared to a non-rehearsal control group. The results support the notion that imagery can be an effective tool to increase self-efficacy in the exercise domain (e.g., Duncan et al., 2011).

However, the finding was no longer significant when pre-intervention exercise levels were controlled for in the analysis suggesting that the imagery was more beneficial for those who began the study with higher exercise levels. These results do make sense because having greater experience with exercise means that these participants would have been more familiar with the physiological, cognitive and emotional experiences described in the imagery script. It is possible that not only could they more readily recall this information from memory but also could more easily image the content of the script. This notion is supported by previous research (Cumming, 2008) and the fact that the participants' MET scores correlated positively with ease of imaging appearance images ($r = .36$, $n = 32$, $p = .026$) and the direction of their images (i.e., how hurtful/helpful they were; $r = .40$, $n = 31$, $p = .04$).

Although variability in the participants' pre-intervention exercise behaviour can be seen as a limitation, the data nevertheless suggests some support for using imagery to bolster self-efficacy levels for exercising and it is important to discuss possible reasons behind it.

The content of the script did not specifically refer to overcoming barriers; however, the imagery still seemed to have an effect on participants' belief in their ability to overcome them. This effect is likely to be due to both the content and structure of the script, which consisted of three parts: (1) preparing for the walk, (2) going on the walk, and (3) completing the walk. This structure allowed participants to rehearse positive thoughts and feelings in relation to the activity in different situations (e.g., feeling confident before the walk). Imaging each stage of the walk may also have helped participants increase the belief that they could overcome different barriers. For example, imaging walking while being full of energy (e.g., "You are full of energy and vitality") and feeling confident that they will complete the walk ("You are confident that you can continue at this pace to complete your work out") are images that might suggest to participants that they will be able to carry out a walk even when they are feeling tired. Including feelings of accomplishment after the walk (e.g., "You are really proud of what you accomplished on today's walk and happy with the effort you made.") may also have elicited the belief that a walk can be completed even when facing a barrier (e.g., discomfort).

Based on social cognitive theory, multiple sources of self-efficacy were therefore referred to in the imagery script (*performance accomplishments, vicarious learning* and *physiological and emotional response toward the activity).* It could also be argued that the script includes a large amount of verbal persuasion. When listening to the script the participants continuously were hearing that they could do things or that they felt certain ways. A specific form of verbal persuasion, self-talk, was not included in the script. But, since combining different sources of self-efficacy has an additive effect (Bandura, 1997; Wise & Trunnell, 2001) it would be a possible way of improving the script even further. The participants could image saying verbal phrases to themselves like "I will finish this walk", "I feel very healthy", and "I am strong" while imaging going for a brisk walk and feeling their body work. To extend our knowledge in how to best develop imagery scripts to increase self-efficacy, future studies should also examine possible differences when varying the number of sources tapped in the imagery script.

For imagery interventions to be effective it is important that the participants adhere to the training. Some of the previous imagery interventions in the exercise domain have reported large dropout rate. For example, 70.24% participants dropped out of the 12 week intervention by Duncan et al. (2011) and 25.27% dropped out of the 4 week intervention by Chan and Cameron (2012). It is possible that the length of the intervention might have contributed to the problem. By comparison, Andersson and Moss carried out a shorter, two week long intervention, and only 9 out of 59 (15.25%) participants dropped out. They did not, however, report how well the imagery group's participants adhered to the imagery rehearsal. This is an important factor to consider because without this information it is not possible to know how often they actually rehearsed the imagery script. The diaries that participants completed in the present intervention demonstrate that most used the script as instructed.

Good adherence in the present study was likely due to several factors. First, both the length of the imagery script and the intervention period were relatively short. Second, the training was not overly repetitive (only once a day) yet still regular enough to make it easier to remember to rehearse. Third, participants received training on how to use the script effectively and they made a rehearsal plan together with the experimenters (e.g., when and where to rehearse the script). Finally, every day around the time of the planned rehearsal participants were sent a text message to remind them to rehearse the script. It is important to keep developing good strategies to increase adherence to imagery interventions and to build on these strategies.

Another factor to consider is the participants' imagery ability. In general, their imagery ability was relatively low at the start of the intervention,[2] which has important implications for informing how imagery interventions might be used to increase exercise behaviour in less active individuals. Lower levels of imagery ability can reduce the effectiveness of an imagery intervention and limit the benefits from its use (e.g., Robin et al., 2007; McKenzie & Howe, 1997). Research has demonstrated that imagery ability can be

[2] The participants' ease of imaging was assessed using the 7-point rating scale added to the EIQ (1 = very hard to image; 7 = very easy to image) and the mean of their imagery ability was 3.31 (SD = 1.32).

improved with LSRT even in individuals who find it difficult to image movements (e.g., Williams et al., 2013). Therefore, all participants received this training in the present study (Williams et al., 2013). Following their imagery intervention, Andersson and Moss (2011) may not have witnessed any increases in participants' self-efficacy because the participants in their study did not receive any prior imagery training. Similarly to Williams et al. (2013), initial training may have led to more effective results. LSRT has not previously been applied to interventions using other types of imagery (e.g., exercise imagery). Results from the present study show that brief LSRT followed by a period of rehearsal can lead to improvements in exercise imagery ability. These results are encouraging because it provides evidence that less active woman can improve their ability to image dovetailing well with the recent findings by Chan and Cameron (2012), who found that inactive individuals improved their imagery vividness during a four-week exercise imagery intervention. An avenue for future research is to more systematically examine whether receiving LSRT not only improves the ability to image thoughts, feelings and actions related to exercise but also greater benefits from the imagery intervention in women who are less active.

In conclusion, the present study investigated whether a brief exercise imagery intervention lasting one week could increase barrier self-efficacy in women who wanted to increase their exercise behaviour. Results from the study demonstrated that those in the rehearsal group experienced a significant increase in barrier self-efficacy compared to those in the control group. However, pre-existing differences between both groups in MET scores meant that once these differences were controlled for there were no significant differences in barrier efficacy between groups. Despite this finding, it seems very promising that imagery can be used to bring about such effects in such a small time frame on those individuals' displaying slightly higher pre-existing exercise behaviour. Future research should investigate the impact of brief imagery interventions on varying exercise behaviours.

Chapter 3

Examining the feasibility of a short intervention for improving exercise imagery ability

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Introduction

Physical activity is well established as important for psychological and physiological well-being (Lee et al., 2012; Reed & Ones, 2006). In spite of evidence supporting recommendations to be regularly active (Haase, Steptoe, Sallis, & Wardle, 2004; Sjöström, Oja, Hagströmer, Smith, & Bauman, 2006; BHF, 2015), less than half of the population of most countries are sufficiently active to reap the health benefits (WHO, 2011a; 2011b). Many studies try to promote physical activity (e.g., see Orrow, Kinmonth, Sanderson, & Sutton, 2012), but adherence to exercise interventions is still very poor (Dishman, 2001).

Exercise imagery, in which individuals imagine themselves exercising, is a promising intervention for improving the initiation and maintenance of physical activity behavior (Giacobbi, Hausenblas, & Penfield, 2005), increasing both intentions to exercise (Andersson & Moss, 2010) and actual exercise behavior (Kim, Newton, Sachs, Giacobbi, & Glutting, 2011). Exercise imagery is categorised into different types. Three of the most researched types within the exercise domain are appearance (e.g., "I imagine toning up by exercising"), technique (e.g., "I imagine form/body position"), and energy (e.g., "To get me energized, I imagine exercising") imagery. Imaging oneself being active can also improve the quality of an individual's motivation (Duncan, Hall, Wilson, & Rodgers, 2012), raise self-efficacy (Weibull, Cumming, Cooley, Williams, & Burns, 2014), and improve feeling states during exercise (Stanley & Cumming, 2010a), with all of these outcomes contributing to enhanced exercise adherence. For example, experiencing improved affective responses during training is linked to future exercise behavior (for a review see Rhodes & Kates, 2015). Another type of exercise imagery is exercise feelings imagery (e.g., I imagine feelings associated with exercise), which has emerged as a positive predictor of revitalization and tranquility (Cumming & Stanley, 2009) and Stanley and Cumming (2010a) have showed that enjoyment, energy, and technique imagery increased participants' revitalization from pre- to post exercise, and led to higher enjoyment during exercise than a control group.

Although everyone can image, individual differences in imagery ability do exist. For example, less active individuals find it harder to generate exercise images compared to those who exercise more frequently (Cumming, 2008). An imagery intervention is likely to be less effective for those who are not able to image effectively (for recent reviews, see Cumming & Williams, 2012 & 2013). Because of such differences, it is common practice for researchers to screen participants for their imagery ability prior to an imagery intervention, and use this as an exclusion criterion for their studies (e.g., Callow, Hardy, & Hall, 2001; Cooley, Williams, Burns, & Cumming, 2013). Unfortunately, this means that individuals who are in most need for an intervention are also least likely to participate due to their low imagery ability. However, imagery ability is not a fixed trait and can be improved with training (for review, see Cumming & Williams, 2013). A more inclusive approach would be to give participants with low imagery ability an opportunity to improve prior to the start of the intervention (Cooley et al., 2013; Cumming & Ramsey, 2009). The main reason why so few studies take this approach is that very little is known about how to best develop imagery ability in exercisers.

Imagery ability is a multidimensional construct, which comprises "an individual's capability of forming vivid, controllable images and retaining them for sufficient time to affect the desired imagery rehearsal" (Morris, Spittle, & Watt, 2005, p. 60). Interventions, therefore, are likely to benefit from addressing these different components of the imagery process. So far, ease and vividness of imaging have received the most attention in sport and exercise domains (Cumming & Williams, 2013). Ease of imaging reflects how effortlessly an individual is able to create and control an image, whereas vividness describes the clarity and sharpness or sensory richness of the image (Anuar, Cumming, & Williams, 2015; Baddeley &

Andrade, 2000; Hall & Martin, 1997). Both dimensions are important when imaging different sensory modalities (e.g., visual and kinaesthetic), but play distinctive roles in the imagery process (Anuar et al., 2015). The ease with which an individual images is thought to reflect three components of the imagery process, namely imagery generation/formation, transformation, and maintenance (Williams & Cumming, 2011), whereas vividness is mainly a characteristic of image generation (see Roberts, Callow, Hardy, Markland, & Bringer, 2008). When measuring ease of imaging it is also important to separately investigate the different types of exercise imagery content. For example, just because an exerciser can image themselves running and feeling full of energy does not mean that they can image running with good technique (Hall, 1998, Kim & Giacobbi, 2009; Williams & Cumming, 2011). Further, controllability refers to an individual's ability to influence the content of their images (Murphy, 1994), and includes how accurately an image can be transformed or manipulated (Moran, 1993), as well as refreshing and maintaining the image (Denis, 1985). If a person cannot control what he or she is imaging and instead generates negative images this may impede the desired outcomes of an imagery intervention (Nordin & Cumming, 2005). Exercisers of different activity levels have reported experiencing negative images (Short, Hall, Engel, & Nigg, 2004), which may in part be due to a lack imagery control. Imagery accuracy is arguable a distinct but related dimension of imagery ability to controllability. It is possible to accurately generate an image but then find it difficult to control.

Several imagery interventions have successfully improved imagery ability in sport via guided imagery (e.g., Cumming & Ste-Marie, 2001; Rodgers, Hall, & Buckolz, 1991). However, to our knowledge, only one study has attempted to improve exercisers' imagery ability (Chan & Cameron, 2012). In their four week intervention, 182 inactive or almost inactive adults were allocated to one of four groups: (a) neutral imagery (i.e., imaging the goal of engaging in exercise?/physical activity?, but without considering its desired outcomes like becoming more fit or being more energised); (b) process imagery (i.e., imaging themselves as they implement their physical activity); (c) approach imagery (i.e., imaging linking their engagement in physical activity with the achievement of desirable end-states); or (d) approach and process imagery, which was a combination of the two strategies. Participants rehearsed recorded scripts three times a day for about five minutes each time, and improved how vividly they could image this content. Other studies have measured ease of generation within the exercise domain (e.g., Cumming, 2008; Stanley & Cumming, 2010a), but no study has been conducted with the aim of improving ease of imaging or controllability.

In the case of poor imagers, regular imagery rehearsal may not be sufficient for improving imagery ability (Wright, McCormick, Birks, Loporto, & Holmes, 2014). Other approaches, such as layering increasing complexity into imagery, may instead be more successful (Calmels, Holmes, Berthoumieux, & Singer, 2004). For example, softball players completed imagery training that introduced variations in imagery content, situations, and environments in progressive stages, and found improvements in imagery vividness (Calmels et al., 2004).

Cumming and colleagues have developed a technique called layered stimulus and response training (LSRT; Cumming et al., 2016). This training breaks down an image and then builds it up again layer by layer. Each time a scenario is imaged, the individual is directed to add a new layer of stimulus (e.g., details of the scene) or response information (e.g., somatic and emotional responses), gradually developing a more vivid image that is easier to generate and control. To test the effectiveness of LSRT, Williams et al. (2013) provided golfers with poor imagery ability either LSRT, motor imagery practice, or visual imagery practice. Although all three groups improved their visual imagery, those who received LSRT found it easier to feel the golf putting action compared to the other groups. Further, the LSRT group significantly improved their golf putting performance after a 5-day intervention. However, LSRT has not yet been used with low frequency exercisers who might benefit most from an imagery intervention to increase their activity levels.

Since dropout is an issue when delivering exercise programmes (Jones, Harris, Waller, & Coggins, 2005), it is important any intervention intended to improve adherence is maximally effective in a short period of time. In the present study, we therefore investigated the feasibility of combining LSRT with one week of guided rehearsal for improving imagery ability among people who want to exercise more. This was compared to LSRT with no rehearsal (i.e., control group). It was hypothesized that both groups would significantly improve in terms of imagery ability dimensions (vividness, ease, accuracy, and controllability) and imagery content (their ease of imaging technique, appearance, energy and enjoyment content), but that the rehearsal group would improve significantly more. Further, only two imagery studies have examined pre- to post changes in feeling states and interest/enjoyment in exercise (Stanley & Cumming, 2010a, 2010b), and a study is yet to show that increased imagery ability is associated with better exercise-related outcomes. Therefore, a second study aim was to investigate if there were changes in these variables from pre- to post-intervention, and to determine if imagery ability at post-intervention was associated with better exercise-related outcomes. It was hypothesized that there would be significant increase in the participants' feeling states and interest/enjoyment from pre-intervention to post-intervention and that there would be a larger increase in the exercise-related outcomes for the rehearsal group than the control group. Further, it was predicted that there would be a stronger relationship between imagery ability and the exercise-related outcomes in the rehearsal group.

Method

Participants

As part of a larger study, 45 women were recruited to participate in an imagery intervention and were randomly assigned to either the control group (*n* = 24) or rehearsal group (*n* = 21). Their ages ranged between 19 and 50 years (*M* = 30.53; *SD* = 10.08) and they were predominantly white (*n* = 39), with other reported ethnicities including black (*n* = 1), mixed (*n* = 3) and Asian (*n* = 2). The mean body mass index (BMI) of the sample was 26.04 (*SD* = 7.19), with 40 % of participants either overweight or obese. They all self-reported having the intention to become more physically active. Participants reported an average energy expenditure in a typical week that was a metabolic equivalent (MET) of 18.89 (*SD* = 19.42). Their main type of exercise was walking (*n* = 21), running/jogging (*n* = 8), aerobics/dance (*n* = 8), using cardio training/gym machines (*n* = 3), or swimming (*n* = 2), with the remaining participants reporting cycling, team sports, or yoga/pilates (*n* = 3) as their primary exercise activity.

Measures

Demographic information. Participants provided information regarding their gender, age, weight, height, and primary exercise activity.

Physical activity levels. The Godin Leisure-Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985) assessed the participants' self-reported exercise behavior. The LTEQ is comprised of three questions and participants are asked to report how frequently they undertake more than 20 minutes of mild (e.g., yoga), moderate (e.g., fast walking), and strenuous (e.g., running) exercise in a typical week. A MET score was calculated by placing the participants' responses in the following equation: (strenuous x 9) + (moderate x 5) + (mild x 3). The LTEQ is a valid measure (e.g., Jacobs, Ainsworth, Hartman, & Leon, 1993).

Exercise imagery ability. A modified version of the Exercise Imagery Questionnaire (EIQ; Hausenblas, Hall, Rodgers, & Munroe, 1999) measured the ease of participants' technique, energy, and appearance imagery (3 items/subscale). This version of the EIQ used in the present study was originally adapted by Stanley and Cumming (2010b) to measure enjoyment imagery, and combined with an ease of imaging rating scale (Cumming, 2008). Each item is rated on a 7-point Likert-type rating scale ranging from 1 (*very hard to image*) to 7 (*very easy to image*). The original EIQ has demonstrated adequate psychometric properties and good internal reliability (e.g., Gammage, Hall, & Rodgers, 2000; Stanley & Cumming, 2010a). The enjoyment subscale has also demonstrated adequate internal consistency (e.g., Stanley & Cumming, 2010a). In the present study the internal reliability ranged between .83-.94 for imagery frequency and .87-.96 for ease of imaging.

General imagery ability. Two single items were used before and after the intervention. One item measured imagery control (i.e., To what extent are you able to modify and alter the exercise images you experience?) and one item measured imagery accuracy (i.e., To what extent are the images you experience an accurate reflection of your exercise participation?).

Post-trial imagery ratings. After each of the three imagery trials during Visit 1 and 2, participants rated how easy it was to image the script using the same scale as the EIQ. The 6 items (Table 3.1) measured the participants' general ease of imaging the script, as well as generating specific aspects of the imagery content including their walking technique, bodily responses to the brisk walk (e.g., muscular feelings, breathing, heart rate), and positive thoughts and feelings. The final two items assessed the realism of their imaged reactions (i.e., vividness) and the extent to which they imaged the scenario as described (i.e., imagery accuracy). The items were based on those used by Stanley and Cumming (2010a) and Williams et al. (2010).

Table 3.1

Means and standard deviations for both groups and ANOVA tests to show the effects over time in both groups of their ability to image the script during Visit 1 and 2

				General ease of imaging[a]	Ease of imaging technique[b]	Ease of imaging body responses[c]	Ease of imaging thoughts and feelings[d]	Vividness[e]	Accuracy[f]
Visit 1	Trial 1	Rehearsal group	M	4.78	3.89	3.72	4.82	4.72	5.22
			SD	.81	1.32	1.27	1.38	.96	.73
		Control group	M	4.39	3.83	3.14	4.52	4.14	4.44
			SD	1.56	1.78	1.49	1.88	1.04	1.34
	Trial 2	Rehearsal group	M	5.28	4.83	5.28	5.47	5.44	5.78
			SD	1.10	1.43	.75	.88	.78	.65
		Control group	M	5.04	4.70	4.68	5.39	4.68	5.17
			SD	1.52	1.11	1.39	1.23	1.13	1.07
Visit 2	Trial	Rehearsal group	M	5.50	5.22	5.22	5.59	5.17	5.39
			SD	1.30	1.59	1.22	1.33	1.15	1.09
		Control group	M	5.09	4.96	4.73	5.17	4.82	5.48
			SD	1.24	1.15	1.45	1.15	.91	85
			F	12.90	12.89	30.61	7.41	8.48	8.41
			df	2	2	1.58	2	2	1.71
			p	.006	< .001	< .001	.01	< .001	.001
			η_p^2	.25	.25	.45	.16	.18	.18

Note. n = 40 for all items except for General Ease (item 1) and Technique (item 2) in which n = 41. [a]In general, how easy was it for you to create the images described in the scenario? [b]How easy was it for you to create the images specifically focusing on your walking technique in the scenario? [c]How easy was it for you to create the images of your body's responses to the brisk walk (e.g., muscular feelings, breathing, heart rate) as described in the scenario? [d]How easy was it for you to create images of positive thoughts and feelings as described in the scenario? [e]To what extent did the imagery scenario realistically reflect the reactions (i.e., thoughts and feelings) you would normally experience during an actual brisk walk of this nature? [f]To what extent did you image the scenario as described?

Interest/enjoyment subscale from The Intrinsic Motivation Inventory (IMI). The interest/enjoyment subscale from the IMI (Ryan, 1982) assessed the participants' enjoyment of exercise, an indicator of intrinsic motivation. It consists of 7 items (e.g., "*This activity was fun to do", "I would describe this activity as very interesting"*), and participants rated each item on a 7-point Likert-type scale ranging from 0 (*Not at all true*) to 7 (*Very true*). Two items were reversed coded before averaging the items. The IMI is a valid and reliable scale used within exercise settings (e.g., McAuley, Duncan, & Tammen, 1989). The internal reliability for the subscale in the present study was .92.

Exercise-Induced Feeling Inventory. The Exercise-Induced Feeling Inventory (EFI; Gauvin & Rejeski, 1993) assessed four exercise-related feeling states: revitalization (e.g., "energetic"), tranquility (e.g., "calm"), physical exhaustion (e.g., "worn-out"), and positive engagement (e.g., "upbeat"). It is comprised of 12 items (3 items/subscale). Items were rated on a 5-point Likert-type scale ranging from 0 (*Do not feel*) to 4 (*Feel very strongly*). The EFI is a valid measure (Gauvin & Rejeski, 1993). It is typically employed as an acute measure (i.e., assessing distinct feeling states experienced "at this moment in time"). However, to investigate the participant's usual feeling states following exercise, we used the same version as Cumming and Stanley (2009) to assess feeling states associated with chronic training. To make this adaptation, items were preceded by the following stem "*Please use the following scale to indicate the extent to which each word below describes how you generally feel after an exercise session".* The internal reliability in the present study ranged between .73-.82.

Imagery diary. Participants in the rehearsal group were given a diary to monitor their daily imagery use. They were instructed to report when and where they rehearsed the imagery script. Participants also rated their ability to image this content with a single item on a 7-point Likert-type scale ranging from 0 (*Not at all*) to 7 (*Extremely*). They assessed how easy it was for them to image their walking technique, body's responses, thoughts and feelings and the content in general.

Procedures

Ethical approval was granted from the university ethics committee where the study took place. Recruitment was aimed at women who wanted to increase their physical activity behavior were recruited using posters, emails, and word-of-mouth. The study comprised of two visits to the lab, with each visit performed 7 days (+/- 1 day) apart, except for one participant in the control group who returned for the second visit after 10 days.

Visit 1. Participants were randomly allocated to one of the experimental conditions and provided with information about the procedures and relevant ethical information (e.g., voluntary nature of their participation and the right to withdraw at any time without any explanation or negative consequences) before giving informed consent. They also provided demographic information and completed questionnaires assessing their physical activity and imagery ability.

The imagery instructions and imagery script were delivered to the participants through headphones and an MP3 player (Packard Bell FunKey Neo). First, participants were provided with pre-recorded instructions on how to image the script. These instructions lasted 1 min and 7 s and involved asking participants to image as vividly, clearly and with as much detail as possible, and to personalize the experience by adding their own details of the walking location and environment.

The response-based imagery script that followed the instructions was 4 min 10 s long. Walking was chosen as the activity to image because it is accessible to most individuals and associated with several positive health effects (for review, see Wanner, Götschi, Martin-Diener, Kahlmeier & Martin, 2012). The content of the imagery script was derived from bioinformational theory (Lang, 1979) and previous research (e.g., Stanley & Cumming, 2010a), and was divided into three parts: (1) preparing for the walk, (2) going on the walk, and (3) finishing the walk. Each part described appropriate thoughts, emotions, and physical sensations relating to the brisk walk. Examples of script physiological response propositions include "You now feel warmer and start to slightly perspire" and "Your body's movements feel light and easy", while cognitive and emotional response propositions include "You feel confident in your technique and enjoying the feelings of your body starting to warm up" and "You feel proud of working hard and the really good workout you are having". The wording of the imagery script was pilot tested with five undergraduate students and revisions made based on their feedback. After listening to the imagery script, participants rated their ease of imaging.

During the next phase of Visit 1, participants received LSRT as previously described by Weibull et al. (2013). The LSRT focused on improving participants' ability to image the content of the imagery script. A copy of the script and LSRT instructions can be obtained from the lead author upon request (also see Cumming et al., 2016 for a detailed description of LSRT). The researcher guided participants individually through this training. Participants started with a simple image of themselves going for a brisk walk for 30 seconds. They then imaged the same scenario three more times focusing on different aspects of the image and then combined these details together in the fifth and last image. For both the LSRT and the imagery script, participants chose the location and environment of their imaged walk. After imaging the scenario the first time, they were asked different questions including how well they could image the walking scenario, what details were included, what aspects they could image well, less well, etc. They were also prompted for appropriate key information to include in the next image.

When focusing on their walking technique, participants were encouraged to image certain details like "striking the ground with the heel of your shoe, rolling through the steps from heel to toe, and finally pushing off with your toes". During the feel scenario, participants were prompted to focus on physical feelings associated with the image such as "Legs moving quickly and the muscles in your legs working". Finally, they were prompted to focus on the emotions and cognitions they would like to experience during the walk, such as "Feeling healthy, energetic, and having a sense of achievement and being determined." Before the last image, participants were asked to combine the different elements (e.g., taking short and quick strides, feeling warm and lightly perspiring, while being happy and feeling healthy). Participants chose which propositions they wanted to include based on which propositions they could image most vividly and felt were the most relevant. Through this training participants practiced how to image these specific elements separately, and how to combine them into a vivid, realistic and facilitative image of themselves walking briskly. A second imagery trial followed the LSRT. This trial was identical to the first one, including the instructions, imagery script, and ease of imagery rating.

Participants in the rehearsal group received an MP3 player containing the same imagery instructions and imagery script received earlier in the visit. Participants in the rehearsal group were asked to listen to the script once a day for seven days. The experimenter discussed with the participants when and where they would rehearse their imagery script as a way to facilitating adherence to this instruction, and gave them a diary to record information about their imagery sessions. Daily text message prompts were sent to remind the participants. Participants in the control group were asked to return the following week (they were not provided with an imagery script nor asked to rehearse their imagery).

Visit 2. The LSRT + rehearsal group participants' diary and MP3 players were collected at the start of the second visit. All participants listened to the imagery script a final time with the same procedures and measurements as Visit 1. The study concluded by thanking participants for their participation and providing them with an information pamphlet about imagery and walking to support their future imagery use and exercise behavior. Everyone also received the imagery script on a CD-ROM for personal use.

Results

Preliminary Analysis

Three participants (one from the control group and two from the rehearsal group) were excluded from the data analysis because they did not attend the second visit, leaving a final sample size of 45 (rehearsal = 21, control = 24).

Cronbach alpha coefficients were between .87 and .96 for all the EIQ ease subscales pre and post intervention, between .83 and .94 for the EIQ frequency subscales, between .73 and .88 for the feeling states, and .92 and .93 for interest/enjoyment. All subscales were above the acceptable level of .70 for demonstrating internal reliability (Nunnally, 1978).

Independent samples t-tests were used to examine between group differences in the exercise imagery ability variables and other relevant variables like BMI and exercise behavior at baseline. Bonferroni adjustments were made when appropriate due to multiple comparisons being performed ($p < .008$ to $p < .05$). The analyses revealed that there were no differences between the groups on any of these variables ($p > .05$).

The participants' imagery ability was generally low before the start of the intervention. Ease of imaging across the four EIQ subscales (energy, enjoyment, technique and appearance) was 3.38 ($SD = 1.40$), while the mean for imagery control and imagery accuracy was 3.53 ($SD = 1.40$) and 3.04 ($SD = 1.46$), respectively.

Main Analysis

In the following repeated measures analyses, Mauchly's test was used to test the assumption of sphericity. When data violated this assumption ($p < .05$), the degrees of freedom of the subsequent univariate tests were reduced by reporting the Greenhouse–Geisser correction (Greenhouse & Geisser, 1959).

Changes in imagery ability from visit 1 to visit 2. Six different 2 group (rehearsal, control) x 3 time (Trial 1 and 2 during Visit 1 and Visit 2 after one week of rehearsal for the rehearsal group) mixed design repeated measures ANOVA were carried out to examine changes in imagery control, vividness, general ease of imaging, ease of imaging technique, body responses, and positive thoughts and feelings during the imagery trials. A Bonferroni adjustment was made due to multiple comparisons being performed ($p < 0.008$). The means and standard deviations of the participants' ease of imaging scores and results from the ANOVA tests are presented in Table 3.1. There was no significant effect for group and no time by group interaction. There was however a significant main effect for time for all the six items measured. Six follow-up post hoc tests (Bonferroni) indicated that both groups improved their ease of imaging the script from the first to second imagery trial during Visit 1, with no further improvements found for the trial during Visit 2.

The effect of LSRT and imagery rehearsal on participants' imagery control and accuracy was investigated via two single imagery ability items (before and after the intervention). A 2 group (rehearsal, control) x 2 time (visit 1, visit 2) mixed design repeated measures ANOVA were carried out. There was a significant effect over time for both imagery control, $F(1, 42) = 23.39$, $p > .001$, $\eta_p^2 = .36$, and imagery accuracy, $F(1, 42) = 52.10$, $p < .001$, $\eta_p^2 = .55$. There was no significant time by group interaction effect for imagery control, but there was a significant time by group interaction effect for imagery accuracy, $F(1, 42) = 5.63$, $p = .022$, $\eta_p^2 = .12$. The means for the rehearsal group changed from 2.86 (*SD* = 1.35) to 5.10 (*SD* = 1.30) and the control group from 3.26 (*SD* = 1.57) to 4.39 (*SD* = 1.62). The Post-hoc analysis revealed that the means for both the rehearsal ($p < .001$) and the control ($p = .001$) groups were greater after the intervention than before the intervention suggesting a significant improvement in accuracy.

A one-way between-groups (rehearsal group and control group) MANOVA was conducted to investigate if the LSRT and imagery rehearsal had an effect on the participants' ability to image technique, energy, appearance and enjoyment images, and determine if there were differences between the rehearsal group and the control group. The results showed there was no time by group interaction effect, and no main effect for group. But there was a main effect for time with a significant increase from before to after the intervention, $F(4, 61) = 6.91, p > .001, \eta_p^2 = .40$. Univariate tests revealed a time effect for: (a) technique imagery, $F(1, 43) = 21.32, p > .001, \eta_p^2 = .33$, the means for the rehearsal group changed from 3.71 (SD = 1.76) to 3.89 (SD = 1.74) and the control group from 2.79 (SD = 1.86) to 4.24 (SD = 1.48); (b) energy imagery, $F(1, 43) = 8.27, p = .006, \eta_p^2 = .16$, the means for the rehearsal group changed from 2.75 (SD = 1.35) to 3.67 (SD = 1.65) and the control group from 2.38 (SD = 1.69) to 2.86 (SD = 1.57); (c) appearance imagery, $F(1, 43) = 10.30, p = .003, \eta_p^2 = .19$, the means for the rehearsal group changed from 4.81 (SD = 1.35) to 5.38 (1.41) and the control group from 5.27 (SD = 1.55) to 5.18 (SD = 1.13); and (d) enjoyment imagery $F(1, 64) = 17.46, p > .001, \eta_p^2 = .29$, the means for the rehearsal group changed from 3.56 (SD = 1.48) to 4.65 (1.49) and the control group from 2.81 (SD = 1.78) to 3.79 (SD = 1.73).

Imagery rehearsal. Participants in the rehearsal group rated how well they could image the script each day of the rehearsal period. Of the 21 participants, 15 rehearsed the imagery script seven times (everyday) as instructed, whereas three participants rehearsed the script six times and three participants rehearsed it five times or fewer. Most participants carried out their imagery rehearsal at home and in the evening.

Four separate one-way repeated measures ANOVAs with a Bonferroni adjustment ($p <$ 0.013) and follow-up post hoc tests examined any changes in general ease of imaging the script, ease of imaging their walking technique, body responses, and positive thoughts and feelings over the seven rehearsal days. The means and standard deviations of the participants' ease of imaging scores during each imagery rehearsal for each imagery type are presented in Table 3.2. The 6 participants with missing data were excluded from the analysis.

Table 3.2

Ease of imaging the imagery script for the rehearsal group (n = 15) during the rehearsal of the script between Visit 1 and Visit 2.

	Rehearsal 1	Rehearsal 2	Rehearsal 3	Rehearsal 4	Rehearsal 5	Rehearsal 6	Rehearsal 7
In general, how easy was it for you to create the images described in the scenario?	4.600 (1.060)	5.067 (1.222)	5.400 (.990)	5.867 (.990)	5.667 (1.050)	5.667 (1.180)	5.800 (1.082)
How easy was it for you to create the images of your *body's responses* to the exercise (e.g., muscular feelings, breath, heart rate) described in the scenario?	3.933 (1.335)	3.867 (1.356)	4.267 (1.033)	4.533 (1.457)	4.867 (1.457)	4.933 (1.487)	5.000 (1.650)
How easy was it for you to create the images focusing on your *walking technique* in the scenario?	4.000 (1.254)	4.467 (1.356)	4.733 (1.335)	4.733 (1.487)	5.000 (1.690)	5.133 (1.642)	5.400 (1.595)
How easy was it for you to create *thoughts and feelings* in the scenario?	3.867 (1.727)	4.133 (1.457)	4.200 (1.082)	4.333 (1.345)	4.667 (1.543)	4.600 (1.920)	4.733 (1.831)

Note. SD are shown inside the brackets.

For general ease of imaging there was a significant main effect for time, $F(3.11, 43.57) = 6.49$, $p = .001$, $\eta_p^2 = .32$, with significant improvements between rehearsal day 1 and days 4 and 5, and between rehearsal day 2 and day 7. Regarding ease of imaging the walking technique, a significant main effect for time was found, $F(6, 84) = 4.75$, $p < .001$ $\eta_p^2 = .25$. There was a significant improvement between rehearsal day 1 and 3 and between day 1 and 7. For the ease of imaging the body's responses, there was a significant main effect for time for the ease of imaging the script, $F(6, 84) = 5.79$, $p < .001$, $\eta_p^2 = .29$. There was a significant improvement between rehersal day 1 and 5. When analyzing the variable ease of imaging thoughts and feelings a significant main effect for time for the ease of imaging the script was found, $F(6, 84) = 2.60$, $p = .023$, $\eta_p^2 = .16$. However, no significant improvements were found between any of the rehearsals.

Feeling states and interest/enjoyment. Five 2 group (rehearsal, control) x 2 time (visit 1, visit 2) mixed design repeated measures ANOVAs were conducted to investigate if there was a difference in interest/enjoyment and feeling states (revitalization, tranquility, positive engagement and physical exhaustion) between Visit 1 and 2 for the control and rehearsal groups. A significant positive main effect for time was found for: interest/enjoyment, $F(1, 42) = 8.79$ $p = .005$, $\eta_p^2 = .173$, the means for the rehearsal group changed from 4.09 ($SD = 1.37$) to 4.56 ($SD = 1.29$) and the control group from 3.69 ($SD = 1.39$) to 4.08 ($SD = 1.15$); physical exhaustion $F(1, 43) = 4.55$, $p = .039$, $\eta_p^2 = .173$, the means for the rehearsal group changed from 1.71 ($SD = 1.02$) to 2.31 ($SD = 0.79$) and the control group from 1.71 ($SD = 1.02$) to 2.07 ($SD = 0.86$); and positive engagement $F(1, 42) = 7.48$, $p = .009$, $\eta_p^2 = .151$, the means for the rehearsal group changed from 2.65 ($SD = 0.64$) to 2.84 ($SD = 0.62$) and the control group from 2.36 ($SD = 0.73$) to 2.62 ($SD = 0.79$); but not for revitalization or tranquility. There was no significant main effect for group and no significant time by group interactions for any of the variables.

Relationships between ease of imaging, feeling states and interest/enjoyment. Partial correlations were used to determine the relationship between post-intervention ease of imaging, interest/enjoyment and feeling states, whilst controlling for pre intervention data. These correlations were run separately for the rehearsal and control groups to determine the impact of the rehearsal period. No significant correlations emerged for the control group, but post-intervention imagery ability was significantly and positively associated with interest/enjoyment, positive engagement, and tranquility for the rehearsal group (see Table 3.3).

Table 3.3

Partial correlations between different types of imagery ability and interest/enjoyment and feeling states at Visit 2 controlling for the first Visit.

Groups	Imagery ability variables	Interest/enjoyment	Positive engagement	Revitalization	Tranquillity	Physical exhaustion
Rehearsal	Technique	.35	.39	-.03	.20	.24
	Appearance	.29	.29	.26	.45*	.20
	Energy	.68*	.53*	.26	.39	-.11
	Enjoyment	.44	.55*	.29	.41	-.17
Control	Technique	.06	.02	.27	.25	-.10
	Appearance	-.16	-.14	-.14	-.23	.01
	Energy	.29	-.01	.21	.23	-.04
	Enjoyment	.31	.12	.01	.04	.10

* Significant correlations at Visit 2 when controlling for the first Visit ($p < .05$)

Discussion

The present study investigated the effect of a one-week guided rehearsal intervention, combined with layered stimulus response training (rehearsal plus LSRT), on imagery ability in women who want to exercise more. This was compared to an LSRT-only control (i.e., no rehearsal). Both the intervention and the LSRT-only control group improved their exercise imagery controllability, accuracy, vividness, body responses and ease of imaging different exercise imagery types, including technique, body responses, and positive thoughts and feelings. Contrary to expectations, greater improvements for the rehearsal plus LSRT group were only seen in imagery accuracy post intervention, and not for the other aspects of imagery ability. In terms of feeling states, both groups also increased the extent of their interest/enjoyment and positive engagement, and reduced feelings of physical exhaustion, but again there was no additional benefit of rehearsal. However, post-intervention imagery ability was significantly and positively associated with interest/enjoyment, positive engagement and tranquility for the rehearsal plus LRST group. However, these associations were not evident in the LRST-only control group. These results show that it is possible to improve exercise imagery ability in a group of women with low imagery ability and low exercise behavior with a relatively short intervention.

Both groups improved their imagery ability over time, with minimal additional benefit of one week of rehearsal. Aligned with previous research, it is likely that the LSRT contributed to this improvement in imagery ability (Williams, Cooley, & Cumming, 2013). During LSRT, participants image a similar scenario multiple times, adding different layers to it thus changing the content of the image. The structure of LSRT encourages individuals to reflect on how they image the scenario. It helps them keep the meaningful and successful elements of their imagery and improve or replace those less effective elements. The LSRT session in this study was very short, consisting of five 30 second repetitions of the image and lasting about 20 minutes in total. An implication is that LSRT is a time efficient method that is easy to implement. Although these results support the value of LSRT in women who want to exercise more, further research is needed to systematically explore its effects and investigate for which types and dimensions of imagery ability this method best works.

The relative lack of effect of the rehearsal period also raises the question of why this practice was not beneficial. It is possible that the one-week intervention was not sufficient to yield any further benefit over LSRT. No exercise imagery researchers have previously reported using a rehearsal period this short in length. In comparison, rehearsal periods in both sport and exercise tend to be longer in duration, for example 16 weeks (Rodgers et al., 1991, Chan & Cameron, 2012). Williams et al. (2013) observed a more immediate improvement in participants' imagery ability over the course of four days.

Both groups in the present study improved different dimensions of their imagery ability. For example, participants in both groups improved how well they could control, modify, and alter the exercise images they experienced from before to after the intervention and in general how accurately they could image their exercise experience. Imagery controllability is seldom measured in sport and exercise imagery research, with the exception of its inclusion in the Sport Imagery Ability Measure (SIAM; Watt, Morris, & Andersen, 2004). The present study is the first time imagery controllability and accuracy have been measured in an exercise imagery intervention. The rehearsal group improved significantly more compared to the control group on one of the post-intervention items measuring accuracy with which an individual images the desired content. This finding suggests that rehearsal can improve this dimension of ability. Through rehearsal, the participants were able to form a more accurate representation of what is to be imaged. Imaging the same content several times gives the individual a possibility to make improvements in the content and quality of the image from one time to the next. Since the imaged activity was walking it was also possible for the participants to reflect on their actual walking between rehearsals and compare this to their imaged walking. It is also likely that being prompted to consider how accurately they imaged a script in the post-rehearsal questionnaire also reinforced the importance of imaging the content correctly, which may have contributed to improved image accuracy. Given these promising results, we recommend that accuracy is assessed as a dimension of imagery ability in future exercise interventions. Considering that only single items were used in the present study and the known limitations of this approach (Diamantopoulos, Sarstedt, Fuchs, Wilczynski, & Kaiser, 2012), research should focus on the development of valid and reliable multi-item exercise imagery ability measures.

Participants in both groups also improved how vividly they imaged the script in the final trial, indicating pre- to post-intervention improvements. More specifically, they improved the extent the imagery scenario realistically reflected the reactions (i.e., thoughts and feelings) participants would typically experience during an actual brisk walk. Chan and Cameron (2012) previously found improvements in exercise imagery vividness after a four-week exercise imagery intervention with a group of inactive individuals. In their study, the participants rehearsed a script three times a day for four weeks while participants in the present study received either LSRT only or LSRT combined with one week of rehearsal. The present study suggests that it is possible to improve exercise imagery vividness in a much shorter timeframe. This is particularly relevant given that participants of the present study, for the most part, reported low exercise levels at pre-intervention. If improvements in imagery ability can occur over a shorter timeframe, it makes imagery interventions more feasible for those who are insufficiently active. Collectively, these studies are encouraging but vividness was assessed using single items only. As such, the validity of the collected data may be limited. There is a need therefore for a more comprehensive and psychometrically sound measure of vividness in the exercise domain.

The participants in the present study not only improved different dimensions of their imagery ability but they also improved imagery ability of different content. Both groups similarly improved their ability to image positive thoughts and feelings and ease of imaging body responses when imaging the brisk walk during the imagery trials. Further, both groups similarly improved their ease of imagining technique, energy, appearance, and enjoyment imagery from pre to post intervention. The participants in the rehearsal group who imaged the script daily during the rehearsal period improved their ease of imaging the script during the rehearsals (assessed after each rehearsal between Visit 1 and 2). They also improved their ease of imaging the scenario in general and in relation to their walking technique, body responses and positive thoughts and feelings. To date, no research study prior to the present study has aimed to improve either of these variables in an exercise context. Research has however shown that kinaesthetic imagery can be improved through rehearsal in a sport context (Rodgers et al., 1991). These improvements may be due to the content of the scripts, for example, several sentences in the script focused on exercise technique and more specifically walking technique and on cognitive, emotional and kinaesthetic responses to the exercise. We recommend that researchers include a follow up time point to examine if these changes have been maintained over a longer time period.

In partial support of the hypothesis, the present study demonstrated that interest/enjoyment, physical exhaustion, and positive engagement significantly increased from before to after the intervention. However, revitalization and tranquility did not significantly increase. Enjoyment, revitalization, tranquility, and physical exhaustion (Stanley & Cumming, 2010a, 2010b) have previously been manipulated with the use of imagery during exercise but to our knowledge, no previous attempt has been made to increase these variables with imagery alone. Future research could be used to further understand the mechanisms through which improvements in the present study occurred. For example, a cross-sectional study could explore the mediating role of imagery ability in the relationship between imagery use and these psychological outcomes. The control group did not receive any rehearsal but showed similar levels of improvements as the rehearsal group. Consequently, the LSRT may have caused these improvements. Research has shown that small bouts of LSRT can lead to improvements in imagery ability and other outcomes reflective of the LSRT content such as golf putting performance (Williams et al., 2013; Wright et al., 2014). During the present study LSRT content included feeling happy, healthy, energetic and motivated. It is likely that imaging these feelings as clearly and vividly as possible helped them to experience these feelings more strongly in relation to exercise.

Finally, when controlling for pre-intervention imagery ability, imagery ability following the intervention was associated with an increase in positive exercise related feeling states and enjoyment in the rehearsal group but not the control group. Positive engagement was positively correlated with ease of imaging energy imagery, and enjoyment imagery, and tranquility was positively correlated with ease of imaging appearance imagery. These results further support the importance of imagery ability highlighted by the revised applied model of deliberate imagery use (Cumming & Williams, 2013). More specifically, the findings support the notion that improvements in imagery ability also affect other variables related to the imagery used during the training (e.g., Robin et al., 2007; Williams et al., 2013).

These relationships only emerged for the rehearsal group suggesting that although the rehearsal group did not improve their imagery more than the control group, the improvements experienced seem to be more meaningful. It is well established within the imagery literature that visual imagery ability tends to improve more quickly that kinesthetic (feeling based) imagery (e.g., Cumming & Ste-Marie, 2001). Within the present study, a similar pattern is likely taking place. With increasing experience with using imagery, it is speculated that the rehearsal group are better able to image more nuanced feelings states associated with the exercise experience and this enables them to become more aware of these feeling states. As a result, a positive relationship is found between their imagery ability and reported feeling states. Similarly, as the rehearsal group becomes more accustomed to using imagery, an added benefit is that their images become more personally relevant and meaningful to them. Therefore, better able to connect with their images and, as a result, will more likely to benefit from them. Based on the Bionformational theory a more meaningful imagery will likely be more vivid and rich (Lang, 1979).

It is important to discuss the practical significance of the findings in the present study. Researchers normally adopt either a 4 or a 5 (out of 7 point Likert-type scale) as the cut off for including individuals in an imagery intervention (Cumming & Ramsey, 2009). However, these traditional cut off values have not yet been validated. The results in the present study suggest that a brief intervention will aid individuals to reach or surpass this cut off for at least some types and dimensions of exercise imagery ability. These findings reinforce the importance of measuring the types of imagery ability of interest to the intervention rather than a general measure of imagery ability (Williams & Cumming, 2011).

A strength of the present study was the breadth and relevance of imagery ability measurement. That is, we measured four dimensions: accuracy, ease of imaging, controllability, and vividness, and items reflected the content that was being imaged (Williams & Cumming, 2011). It is possible that not all of the possible improvements in imagery ability made by participants were captured using the modified version of the EIQ and single items. In future, other qualitative and quantitative methods to complement self-report, such as interviews and chronometry (Collet, Guillot, Lebon, MacIntyre, & Moran, 2011), could be considered. The use of single items to measure certain dimensions of imagery ability can also be viewed as a limitation due to the lack of validity and reliability information. With that said, however, the findings resulting from these dimensions in the present study are promising and suggest valuable avenues for the development of future exercise imagery ability measures. The use of single items in an intervention study was a pragmatic choice to keep the work load for the participants kept to a minimum (for more advantages with single items, see Hoeppner, Kelly, Urbanoski, Slaymaker, 2011).

The use of the LTEQ is also considered a methodological limitation. The use of a more objective measure like pedometers may have resulted in more reliable data of the participants' exercise behavior. Further, Godin (2011) suggested excluding mild intensity exercise from the LTEQ and only use the scores for moderate and strenuous activities. Because we were simply describing participants' activity levels, including their mild levels, we used the LTEQ as it was originally intended.

That only women were recruited for this study may limit the generalizability of the findings. However, identifying an intervention that is effective for women was of interest due to their lowered patterns of physical activity compared to men (Colley et al., 2011). A future study could seek to replicate the findings with a larger sample and both males and females to compare the effects between genders.

In summary, it is feasible to improve imagery ability and affective responses to exercise in women with low physical activity level through a brief imagery intervention. Notably, adherence to the rehearsal period was higher than with previous interventions (Chan and Cameron, 2012) with 15 of the 21 rehearsal group participants rehearsing the script every day as instructed. The improvements in participants' imagery ability from pre to post intervention, even with the relatively short LSRT intervention, suggests that this brief intervention could be used in both research and applied settings to enhance imagery ability. This finding is significant for practitioners because it demonstrates that a relatively short intervention can improve participants' ability to generate and control their imagery.

With further rehearsal, these images also appeared to become more accurate. Therefore, exercisers unfamiliar with imagery may still benefit from this type of intervention given opportunities to develop this skill at the outset. One week of rehearsal only had marginally more effect than the initial LSRT suggesting that due to LSRT's immediate effects, a longer rehearsal period is needed for further improvements beyond those provided by the training. The results from the present study are very encouraging and indicate that initial imagery training should be included when conducting exercise imagery interventions with the aim of increasing physical activity.

CHAPTER 4

GENERAL DISCUSSION

The overall aim of this thesis was to examine tenets of the revised applied model of deliberate imagery use (Cumming & Williams, 2013) in an exercise context.

Summary of the studies

The aim of the first study (Chapter 2) was to examine if a short (i.e., one week) period of imagery rehearsal could increase barrier self-efficacy in women who wanted to increase their exercise behaviour. All participants received LSRT and were then divided in one rehearsal and one control group. It was expected that the rehearsal group would significantly increase their barrier self-efficacy while the control group would not.

One week of imagery rehearsal led to greater increases in barrier self-efficacy compared to no rehearsal. The finding was, however, no longer significant when pre-intervention exercise levels were controlled for. These results suggested that the specific exercise imagery used was more beneficial for those with higher activity levels. The results are still promising since they were obtained after only one week of imagery rehearsal. Previous research has also shown that it is possible improve self-efficacy in a longer time frame when combined with an exercise program (Duncan et al., 2011). More research is needed on the use of exercise imagery to increase self-efficacy and the mechanisms behind these effects to learn how much training is needed, what exercise experiences are necessary, and how to best implement the imagery. The participants adhered well to the training, probably because both the imagery script and the intervention period were short, the training were simple and regular with one session a day and since the participants received training on how to use the script effectively.

The aim of the second study (Chapter 3) was to investigate the feasibility of combining LSRT with one week of guided rehearsal for improving imagery ability among women who want to exercise more. This was compared to LSRT with no rehearsal (i.e., control group). A second study aim was to investigate if there were changes in these variables from pre-intervention to post-intervention, and to determine if increased imagery ability at post-intervention was associated with better affective responses to exercise (feeling states and interest/enjoyment). It was anticipated that both groups would improve significantly in terms of imagery ability dimensions and imagery content and that the rehearsal group would improve significantly more. Further, it was predicted that there would be a significant increase in feeling states and interest/enjoyment from before to after the intervention and that the increase would be greater for the rehearsal group. It was also hypothesized that there would be a stronger relationship between imagery ability and the affective responses to exercise in the rehearsal group.

Both the intervention and the LSRT-only control group improved their exercise imagery controllability, vividness, body responses and ease of imaging different exercise imagery types, including technique, body responses, and positive thoughts and feelings. Greater improvements for the rehearsal plus LSRT group were only seen in imagery accuracy. Both groups increased their interest/enjoyment and positive engagement, and reduced feelings of physical exhaustion, but again there was no additional benefits of rehearsal.

Theoretical implications

The results from study 1 (chapter 2) support the proposition of the RAMDIU, that imagery can be used to increase self-efficacy, and more specifically that exercise imagery can be used to increase barrier self-efficacy. This has been successfully tested previously (Duncan et al., 2011) but the results from this thesis show that it is possible in only one week. This novel finding also challenges the idea to why no significant changes in self-efficacy were reached by Andersson and Moss (2010). Andersson and Moss suggested that the temporal lag of self-efficacy prevented the participants from experiencing improvements in their exercise self-efficacy after only two weeks (Bandura, 1997).

The results from study 2 also support another important notion of the RAMDIU, which is that specific content can lead to different outcomes (Cumming & Williams, 2013). In this study, the script focused on positive affect, motivation and self-efficacy, but it was not explicitly designed to increase self-efficacy, nor did it include imagery content focusing on this type of self-efficacy. In spite of this, exercise barrier self-efficacy was improved.

The results go in line with self-efficacy theory (2006), proposing that past mastery experiences influence future efficacy expectations. Richer past mastery experiences probably may also make it easier for exercisers to think back to moments when successfully dealing with different barriers. The bioinformational theory (Lang, 1977, 1979) could also be used in the interpretation of the results. More experienced exercisers most likely have a lot more memories of different past exercises to draw from in their long-term memories. This can help them combine stimulus, response and meaning propositions in a better way and hence creating more meaningful imagery. In turn, this may help them benefit more from exercise imagery scripts.

Further, the results in study 2 support the importance of the individual (Who) during imagery interventions, highlighted in the RAMDIU. More specifically the importance of the individual's exercise behaviour is supported, since exercise behaviour was found to influence the outcome of the intervention, the barrier self-efficacy. This finding reinforces the value to tailor the intervention to the participants in the group, not necessarily on an individual level but in terms of common denominators among the group members.

The findings from study 2, that the post-intervention imagery ability correlated with the increase in affective responses to exercise for the rehearsal and not the control group, demonstrate the importance of imagery ability highlighted in the RAMDIU. Given the importance of imagery ability (e.g., Cumming, 2008), it is impressive that individuals low in imagery ability can improve their ability to image different types of exercise images in a short time. Quick improvements in imagery ability has previously been demonstrated in sports (Williams et al., 2013), but this is the first study to provide results like these in the exercise domain.

For the first time LSRT, which is based on the bioinformational theory (Lang, 1979) has been implemented in physical activity research. The results support the use of LSRT in this domain and there should not be any reason not to use it before the start of an exercise intervention, even if imagery is not a technique included among the intervention techniques. Most, if not all, exercise participants will probably experience exercise images during the intervention, either spontaneous or deliberate. Imagery has previously shown that it can both have a facilitative and debilitative effect (Duncan et al., 2012; Nordin & Cumming, 2005b). This notion combined with the results from study one, demonstrating the mediating role exercise imagery can have, it is valuable to teach individuals how to become more aware of their imagery experiences and preferences, as well as how to control their images better.

Limitations

A limitation of the studies included in the thesis is the potentially problematic nature of the EIQ (Hausenblas, Hall, Rodgers, & Munroue, 1999) which was used to measure exercise imagery ability use, and more specifically the use of energy, technique and appearance imagery. The enjoyment subscale which has been added to the EIQ measures only imagery content. The importance of separating imagery functions from imagery content have been stressed by several researchers during the past decade (e.g., Short, Ross-Stewart, & Monsma, 2006; Murphy et al., 2008). The problem with the mix between functions, outcomes and content is that it makes the results more difficult to interpret. In most cases, the participant would probably have imaged energy content when the item focused on energy function but sometimes the same content is used for different functions and the same content can be used for several functions at the same time (Bernier & Fournier, 2010; Callow & Waters, 2005; Cumming & Ramsey, 2009; MacIntyre & Moran, 2010; Nordin & Cumming, 2005a).

In regards to exercise imagery ability, no conventional imagery ability questionnaire was employed. Instead a method with ease of imaging companion scales added to the revised EIQ was used. This measure has been employed in previous research (e.g., Stanley & Cumming, 2010b) and seems to function well based on psychometric results. The fact that no questionnaire specially developed to measure exercise imagery ability was used remains a limitation.

No follow-up assessments were made for any of the intervention studies. It would have been valuable what would have happened with the improvements in barrier self-efficacy and imagery ability over time. It would have given valuable insights into how ecologically meaningful the improvements were. No follow-up assessments have previously been included in studies focusing on exercise imagery ability or exercise imagery interventions with the aim of improving self-efficacy.

Applied Implications

Some applied implications can be derived from the research in the present thesis. The participants adhered well to the intervention study which indicated that the strategies used were effective. For interventions to be successful it is inherently important that the participants adhere to the programs. It is therefore of value to keep using and refine successful strategies. The main strategies used in the intervention were short imagery script and a short and realistic intervention plan. The participants received training in how to use the script effectively and a plan was created for how to carry out the training. The participants also received daily reminders to rehearse the script.

LSRT sessions which previously have been very useful in the sport domain (Williams et al., 2013), are recommended in the beginning of or before the exercise imagery interventions to ensure maximal benefits of the interventions. The findings from study 2 indicated that LSRT helped improve the participants' exercise imagery ability even though their imagery was relatively low before the intervention.

Future Research

The value of exercise imagery has been further strengthened by the findings in the present thesis. However, there are still a lot of research that needs to be carried out to further improve the application of exercise imagery and the present thesis has generated further questions.

LSRT has previously been tested on individuals with low sport imagery ability (Williams et al., 2013) and it was found to be an effective strategy for improving imagery ability. In study four the LSRT was carried out on participants with relatively low exercise imagery ability and exercise behaviour. Even though their imagery ability was low and the sample included completely sedentary individuals, it would be useful to further test the LSRT in groups of completely sedentary individuals, since they are likely to be in the most need of effective methods of improving imagery ability (Cooley et al., 2014). Research by Chan and Cameron (2012) has shown that it is possible to improve imagery ability of completely sedentary individuals but their intervention was relatively long, involved intensive training and only focused on vividness.

The EIQ should be improved so that it only measures imagery content, which will improve its validity. The subscales measuring other constructs, such as imagery functions and outcomes, should be replaced with items tapping solely imagery content. To further improve its validity, it is also recommended that studies using a think-aloud protocol (see for example Ercikan, Arim, Law, Domene, Gagnon, & Lacroix, 2010) are carried out to find out exactly how the different subscales are understood and interpreted by participants.

Research has demonstrated that exercise imagery predicts both exercise induced feeling states and exercise enjoyment (Cumming & Stanley, 2009). Through experimental studies it has also been shown that exercise imagery can be used improve affective responses to exercise. This is also supported by the results in study 2.

It is, however, not clear what mechanism are behind these effects and what role exercise imagery has. To help individuals experience more facilitative affective responses to exercise it is imperative to learn more about what mechanisms explain the relationship between exercise behaviour and affective responses to exercise such as exercise induced feeling states and interest/enjoyment. Important questions are which imagery types are most effective, and which imagery types influence which affective responses, and whether different types of exercise images function as mediators.

Conclusion

The present thesis supports the use of imagery as a self-regulation technique for exercisers who want to continue with their exercise program and individuals who want to start exercising. The findings reinforce the notion that exercise imagery can be used to improve exercise barrier self-efficacy. Further, the research carried out led to the novel finding that the frequency of general exercise behaviour influences the effectiveness of imagery used to improve barrier self-efficacy.

The ability to use exercise imagery can be improved even when individuals have a low ability at baseline. This reinforces previous preliminary work on exercise imagery (Chan & Cameron, 2012) and is important since less active individuals possess reduced exercise imagery ability than more active individuals (Cumming, 2008). Individuals who otherwise would be excluded from participation could, through pre-intervention imagery training, improve their imagery ability and hence be included in exercise imagery interventions.

Lastly, the research carried out within the scope of this thesis further demonstrates the complexity of imagery and supports the use of RAMDIU to structure and guide future research and applied work.

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