Measurement of Sport and Exercise Imagery

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ABSTRACT

Research has demonstrated that imagery can positively influence athletic performance, and recently it has been shown to also influence exercise behavior. Given the importance of imagery in sport and exercise, valid and reliable measures of imagery are necessary. This paper first outlines the questionnaires that have been developed to assess imagery ability. Next, the questionnaires constructed to measure the use of imagery in sport, exercise, and athletic injury rehabilitation are discussed. For each questionnaire, the nature and content of the instrument is described, the psychometric characteristics of the instrument are given, and research supporting the use of the questionnaire is provided. Finally, directions for future research in imagery measurement are discussed.

Measurement of Sport and Exercise Imagery

Applied sport and exercise psychologists have advocated the use of psychological skills for performance enhancement. One of the skills that has received considerable attention is imagery. Denis (1985) defined imagery as a psychological activity that evokes physical characteristics of any object, person, or place that is absent from our perception. Both athletes and exercisers use imagery to aid in their performances (Hall, Rodgers, & Barr, 1990; Hausenblas, Hall, Rodgers, & Munroe, 1999). Research has clearly demonstrated that imagery can positively influence athletic performance (e.g., Blair, Hall, & Leyshon, 1993; Feltz & Riessinger, 1990; Martin & Hall, 1995; Rodgers, Hall, & Buckolz, 1991), and more recently it has also been shown to be related to exercise behavior (Gammage, Hall, & Rodgers, 2000).

Paivio (1985) suggested that imagery influences performance through two functions: cognitive (e.g., performance improvement), and motivational (e.g., arousing emotions and imagining achieving goals). Given that imagery serves these two functions, it is not surprising that it has often been successfully used as an intervention to improve sport performance (e.g., Blair et al., 1993; Daw & Burton, 1994; Feltz & Reissinger, 1990; Fenker & Lambiotte, 1987; Hughes, 1990; Martin & Hall, 1995; Rodgers et al., 1991). Hall (1995, 2001) has proposed that it can also be employed as an intervention to increase exercise participation and adherence, however, this proposal has yet to be investigated.

Early work investigating imagery in sport focused on the use of imagery to enhance skill learning (i.e., a cognitive function of imagery), as well as attempting to determine the ideal combination of physical and imagery practice (see Driskell, Copper, & Moran, 1994 for a review). More recently, the motivational role imagery plays in both sport and exercise has received increased attention (Hall, 2001). Like any construct, in order to adequately assess imagery, valid and reliable measures are necessary. Thus, researchers have attempted to develop measures of imagery in physical activity settings. While it is possible to measure imagery using a number of procedures (e.g., experimental procedures or manipulating relevant item attributes), this article will focus on the measurement of individual differences in imagery as assessed by questionnaires. This approach to measuring imagery in sport and exercise has been extensively employed and has focused on two issues: 1) the measurement of imagery ability (e.g., vividness, controllability, ease of imagery), and 2) the measurement of imagery use, especially why athletes and exercisers use imagery. In general, earlier measures focused on imagery ability, assessing whether people were good or poor imagers of movement. More recent measures have focused on measuring the use of imagery by athletes and exercisers. Questionnaires developed to measure each of these aspects of imagery, ability and use, will be considered in turn.

Measurement of Imagery Abilities

Several measures have been developed to assess different aspects of imagery ability, including the vividness of the image, the controllability of the image, the ease of imagery, and the ability to image movements and

sport scenes. While tests of imagery ability can be either objective or subjective in nature, these two types of measures do not assess the same abilities (see Ernest, 1977). Subjective (or self-report) tests have been most widely used in the physical activity domain. Furthermore, Katz (1983) has argued that subjective tests are superior to objective ones as they are more directly linked to imagery. In physical activity settings, three questionnaires have been most frequently employed to assess imagery ability: the Vividness of Visual Imagery Questionnaire (Marks, 1973), the Movement Imagery Questionnaire (Hall & Pongrac, 1983) and the Vividness of Movement Imagery Questionnaire (Isaac, Marks, & Russell, 1986). Gregg and Hall (in press) have recently developed another questionnaire, the Motivational Imagery Ability Measure for Sport, to assess motivational general sport imagery ability.

Vividness of Visual Imagery Questionnaire (VVIQ). Marks (1973) developed the VVIQ as an assessment of the vividness of visual images, in order to classify individuals as either 'good' or 'poor' imagers. The questionnaire consists of 16 items: five visual items borrowed from Bett's (1909) Questionnaire Upon Mental Imagery and 11 items constructed by Marks. The items refer to common situations and scenes and the participant's task is to rate the vividness of the visual image that each item evokes. Each item is rated twice, once with the eyes open and once with the eyes closed. Ratings are made using a 5-point scale with the anchors being 1 = perfectly clear and vivid as normal vision, and 5 = no image at all, you only "know" that you are thinking of the object. The psychometric properties of this instrument have been reported to be satisfactory (Marks, 1973, 1989). While the VVIQ has been used in sport research, it has two limitations. First, it assesses only visual imagery, not kinesthetic imagery. Second and more importantly, it does not assess imagery ability related to movement. Rather, it asks people to image stationary objects or scenes. As noted by Hall, Pongrac, and Buckolz (1985), if a relationship between imagery ability and motor performance is to be clearly demonstrated, then measures of visual and kinesthetic imagery specifically related to movement are needed.

Movement Imagery Questionnaire (MIQ). Hall and Pongrac (1983) developed the MIQ to assess visual and kinesthetic movement imagery. It is comprised of nine visual imagery and nine kinesthetic imagery items, each of which involves the movement of an arm, leg, or the entire body.

In order to complete each item, four steps are required. The starting position for each movement is described, and the participant then takes this position. The movement is next described to the participant, who physically performs it. Third, the participant retakes the starting position, and images the movement without physically performing it. Finally, the participant rates the ease or difficulty of imaging the movement on a 7-point scale anchored by 1 = very easy to picture/feel and 7 = very difficult to picture/feel. Psychometric evaluation of the MIQ has demonstrated adequate reliability and validity. Both the visual and kinesthetic imagery subscales have shown sufficient reliability co-efficients (.89 for visual and .88 for kinesthetic, Atienza, Balaguer, & Garcia-Merita, 1994; .87 for visual and .91 for kinesthetic, Hall et al., 1985). Hall et al. (1985) also reported a test-retest reliability co-efficient of .83. Finally, Atienza et al. (1994) found support for the two-factor structure, with visual items loading on the first factor, and kinesthetic items loading on the second.

Goss, Hall, Buckolz, and Fishburne (1986) found that imagery ability was related to the acquisition of movements. Individuals were classified into one of three groups based on their MIQ scores: low visual/low kinesthetic (LL), high visual/low kinesthetic (HL), and high visual/high kinesthetic (HH). Individuals in the HH group learned simple movements in the fewest number of trials, while the LL group required the greatest number of trials. Furthermore, Hall, Buckolz, and Fishburne (1989) found that high imagers (as classified by their MIQ scores) reproduced simple physical movements more accurately than did low imagers.

Vividness of Movement Imagery Questionnaire (VMIQ). Isaac et al. (1986) developed the VMIQ in order to assess the vividness of movement imagery. This questionnaire is comprised of 24 items related to the visual imagery of common movements such as catching a ball with two hands or reaching for something on tiptoe. Participants image each item in two ways: first as if 'watching someone else do it' and second as if 'doing it yourself.' Each item is rated on a 5-point scale ranging from 1 = perfectly clear and as vivid as normal vision, to 5 = no image at all, you only "know" that you are thinking of the skill. Because the items all refer to everyday situations, it is an appropriate test for individuals of a wide variety of age and experience levels. The VMIQ has also demonstrated adequate test-retest reliability (Atienza et al., 1994; Isaac et al., 1986).

Further support for the VMIQ has been established. Campos and Perez (1990) found a single factor to underlie the VMIQ, which was defined as the vividness of visual imagery. Finally, Atienza et al. (1994) found a correlation of .81 between scores on the VMIQ and the VVIQ (Marks, 1973).

Isaac (1992) has argued that the VMIQ provides a reliable assessment of movement imagery ability. Based on VMIQ scores, novice and skilled trampolinists were divided into high and low imagery ability groups. In addition, each individual was assigned to an imagery practice group or a control group (i.e., no imagery). Each group learned and/or improved three trampoline skills, each over a 6-week training period. Participants in the imagery practice group showed significantly greater improvement than those in the control group, regardless of skill level. However, high imagers showed significantly more improvement than low imagers. Isaac concluded that motor skills could be significantly improved through the use of mental imagery, especially for those with high imagery ability.

Comparing the MIQ and the VMIQ. While both the MIQ and the VMIQ are self-report questionnaires designed to assess movement imagery, they may not assess the same constructs. Hall and Martin (1997) found the correlation between the visual imagery subscale of the MIQ and the VMIQ to be .65, while the correlation between the kinesthetic imagery subscale of the MIQ and the VMIQ was only .49. As noted above, Campos and Perez (1990) found a single factor to underlie the VMIQ that they defined as the vividness of visual imagery. Thus, while the MIQ assesses both visual and kinesthetic imagery related to movement, the VMIQ appears to assess only visual imagery of movement.

The situation and participants may dictate which of these instruments is most suitable in a given situation. The VMIQ may be more appropriate than the MIQ in some situations since it is easier and faster to complete. In addition, no physical movements are required. Thus, for large groups of people, or for special populations for whom some physical movements may be difficult, the VMIQ may be the instrument of choice. However, the MIQ does tap into both visual and kinesthetic imagery ability, and describes each movement in detail, so all participants rate exactly the same movements. Consequently, for smaller groups of young, fit individuals, the MIQ may be more appropriate.

Movement Imagery Questionnaire – Revised (MIQ-R). In order to improve upon some of the weaknesses of the MIQ (i.e., length and complexity), Hall and Martin (1997) made several revisions. Items that participants often failed to answer were removed, redundant items were eliminated, and the rating scale was reversed (i.e., high scores represented higher imagery ability) to enhance clarity. The resulting MIQ-R is comprised of four visual and four kinesthetic items, which are completed in the same manner as the items on the MIQ. Each item is rated on a 7-point scale, ranging from 1 = very hard to see/feel to 7 = very easy to see/feel. Hall and Martin (1997) found that the MIQ and MIQ-R subscales were highly correlated (r = -.77 for the two visual and the two kinesthetic subscales). While these results indicate that the MIQ-R may be a useful substitution for the MIQ, further tests of its psychometric properties are required.

Motivational Imagery Ability Measure for Sport (MIAMS). Recently, Gregg and Hall (in press) developed a measure of motivational general sport imagery ability. The MIAMS is composed of four Motivational General-Mastery (i.e., being confident, positive, and mentally tough) and four Motivational General-Arousal (i.e., psyching up, relaxing) imagery scenarios. An example MG-M imagery scenario is:

Imagine that following a break in the competition you are having a difficult time "getting back into it", have made some errors and are having a difficult time overcoming these feelings. You clear your mind and let that mental tension leave you. You then return your focus to the competition and feel more aware of your surroundings. You see your opponents and the competition setting and feel in control of the situation.

An example MG-A imagery scene is:

Imagine yourself about to begin a competition in your sport. As you finish your preparations in the final few minutes before the competition begins you notice the feeling of some "butterflies in your stomach". You notice your palms are a bit sweaty and your heart is beating a little quickly. You know these symptoms indicate that you are a little bit excited, this is good, and that you are ready to compete.

Participants read the scene, form an image, and rate that image. Each scene is rated on a 7-point Likert scale for two characteristics:

emotion (1 = no emotion to 7 = very strong emotion) and ease (1 = not at all easy to form to 7 = very easy to form).

Results of confirmatory factor analyses have supported the two-factor structure of the MIAMS consisting of MG-M and MG-A imagery, with each factor assessed on two rating scales, emotion and ease. In addition, favorable internal consistencies for the items designed to assess each factor have been found. Thus, research provides some evidence that the MIAMS has acceptable psychometric properties and may be a useful instrument for the assessment of motivational general imagery abilities

These questionnaires are all useful for measuring imagery ability. However, they measure only some aspects of imagery ability. Other aspects of imagery ability, such as controllability, preferred imagery style, or unvividness may also be important dimensions to assess (Hall & Martin, 1997). Moreover, these questionnaires have been designed primarily for research, rather than applied purposes (Hall, 1998). It has been suggested that it is necessary to assess an athlete's imagery ability in order to develop and implement an imagery training program (Janssen & Sheikh, 1994). While these measures may be helpful for this purpose, caution must be exercised. Though they give an indication of how good an individual may be at imaging specific movements or scenes, they do not indicate how good that individual might be at using imagery for other functions in sport and exercise (e.g., imaging goals). The various functions of imagery that are used by athletes and exercisers are considered in the following sections.

Measuring Imagery Use in Sport

Examining athletes' use of imagery has been a major focus of imagery measurement in sport for more than a decade. The instruments designed to assess imagery use in sport generally take one of two forms: imagery as one of many psychological skills assessed, or as a measure specifically of imagery use.

Psychological Skills Inventory for Sports (PSIS). Mahoney, Gabriel, and Perkins (1987) developed the PSIS in order to identify skills that distinguish elite level athletes from non-elite ones. The PSIS is composed of five factors: anxiety/confidence, motivation,

concentration, mental preparation, and team orientation. Within the mental preparation subscale are five items related specifically to imagery use. One of the major findings of this research was that elite level athletes relied more on internally referenced and kinesthetic preparation than did non-elite athletes.

The true/false format of the PSIS was cited as a major limitation of the instrument, therefore, it was subsequently modified to have participants respond to questions on a 5-point Likert scale, ranging from 0 = strongly disagree to 4 = strongly agree. This 45-item version measures six constructs: anxiety control, concentration, confidence, motivation, team focus, and mental preparation. While the revised version of this instrument, the PSIS R-5, has been used in various studies (e.g., Mahoney, 1989; White, 1993), the reliability and validity of this measure have been somewhat problematic. Internal consistency (reported only for the entire scale) and split-half reliabilities for the PSIS R-5 have been low (alpha = .64, split-half = .57; Mahoney, 1989). The validity of this instrument has also been problematic, since non-elite athletes scored higher than did elite athletes on some subscales (Mahoney, 1989).

Given these concerns, Chartrand, Jowdy, and Danish (1992) re-examined the PSIS R-5 in 340 intercollegiate athletes from a wide variety of sports. The results from this study confirmed problems with the PSIS R-5. Internal consistencies were relatively low for each subscale. In particular, the mental preparation subscale had an alpha of -.34. Also, some items on this subscale were negatively correlated with one another, indicating the scale might be conceptually ambiguous. In addition, confirmatory factor analysis did not support the 6-factor structure of the PSIS. Thus, Chartrand and colleagues suggested that before this instrument is used for either research or applied purposes, further work on it should be conducted.

Imagery Use Questionnaire (IUQ). Hall et al. (1990) developed the IUQ to further our understanding of imagery use by athletes of various skill levels, competing in a variety of sports. They considered when, where, and how imagery was used in training and competition. The IUQ consists of 35 items which assess the frequency of imagery use and ease of imagery use, measured on a 7-point scale (1 = never to 7 = always, or 1 = very difficult to 7 = very easy, respectively). Two additional questions require a yes/no answer. The results of this study revealed a number of

findings about athletes' imagery use. Athletes use imagery more for competition than training. In general, their imagery sessions are not very structured or regular. Internal and external visual imagery are used with about equal frequency by athletes. Also, competitive level influences imagery use; higher level athletes use more imagery. The authors suggested that athletes use imagery for a variety of functions including to stay focused, increase self-confidence, and to control emotions and arousal, as well as to enhance performance.

While this questionnaire yielded some important preliminary information about athletes' use of imagery, no psychometric analysis was conducted on it. Subsequent work on the IUQ led to the development of several sport specific versions. The first of these sport specific versions was the IUQ for Figure Skating (Rodgers et al., 1991), while the second was the IUQ for Rowers (Barr & Hall, 1992). Each of these questionnaires was developed based on the general version of the IUQ, but modified to be specific for the sports involved. Athletes and coaches from each of the respective sports participated in the development of these questionnaires in order to ensure that items were relevant and unambiguous.

The IUQ for Figure Skating. The IUQ for Figure Skating (Rodgers et al., 1991) assesses skaters' familiarity with and use of imagery. It consists of 37 items rated on a 7-point scale ranging from 1 = never to 7 = always. It was developed as part of a research study designed to assess how skaters' use of imagery changes when involved in an imagery-training program. As a result of the program, skaters increased their use of imagery before and after practice, increased their use of an internal imagery perspective, and increased the controllability of their images. In addition, they were better at visualizing parts of their jumps, visualizing themselves winning competitions, and feeling body control. Finally, their imagery sessions became more structured.

The IUQ for Rowing. The IUQ for Rowers (Barr & Hall, 1992) was developed as part of a research project to examine how variables such as age, gender, and competitive level influence imagery use. This version of the IUQ consists of 41 items rated on a 7-point scale ranging from 1 = never to 7 = always. Some of the findings were that imagery is used most often in conjunction with competition, imagery sessions are not very structured or regular, and kinesthetic imagery is used

more than visual imagery. Age and gender had little influence on imagery use. However, level of competition did influence imagery use; elite level rowers had more structured and regular imagery sessions, imaged themselves executing a pre-race routine more, used more kinesthetic imagery, and imaged themselves rowing incorrectly less often than novice rowers.

While sport specific versions of the IUQ for figure skating and rowing have yielded important information about imagery use by athletes, neither has been subjected to psychometric evaluation. However, a version of the IUQ for soccer players was developed, and the psychometric properties of this instrument were evaluated.

The IUQ for Soccer Players. The purpose of developing the IUQ for Soccer Players (Salmon, Hall, & Haslam, 1994) was to investigate the motivational and cognitive functions of imagery used by soccer players at varying skill levels. This questionnaire was partly based on Paivio's (1985) framework outlining how imagery influences motor performance. Within this model, Paivio (1985) suggested that imagery can serve both motivational and cognitive functions, and that each can work at either a general or specific level. Cognitively, imagery involves rehearsing skills or strategies of play. Motivationally, imagery can include goals, goal-related behaviours, or emotion-arousing situations. Thus, according to Paivio's (1985) framework, there are four functions of imagery. Cognitive general (CG) imagery refers to imaging strategies of play. Cognitive specific (CS) imagery involves imaging specific skills. Motivational general (MG) imagery involves images related to physiological and psychological arousal, as well as mastering specific situations (e.g., being confident). Finally, motivation specific (MS) imagery refers to imaging goal-related behaviours, such as winning a medal.

The IUQ for Soccer Players is made up of four sections. The first contains demographic questions (e.g., age, gender, experience). The second section contains questions relating to the general use of imagery (e.g., practice versus competition). The third section is made up of questions based on Paivio's (1985) model (i.e., cognitive and motivational, specific and general). The final section relates to questions about auditory imagery (e.g., talking during a game).

Salmon et al. (1994) examined the psychometric properties of section three of the IUQ for Soccer Players. Internal consistency co-efficients

for the 4 subscales (i.e., CG, CS, MG, and MS) ranged from .75 to .85, and test-retest reliabilities ranged from .55 to .92. Factor analysis (principal components analysis, varimax rotation), yielded a relatively well-defined four-factor solution. The first two factors were labeled motivational general and motivational specific. Factors three and four were labeled cognitive general and cognitive specific, although several items loaded on both factors.

In Salmon et al.'s investigation of 90 national, 112 provincial, and 161 non-elite level soccer players, the following results were found. Imagery was used more in conjunction with competition than with practice, and imagery of specific skills was used frequently. Visual and kinesthetic imagery were used with about the same frequency. Gender differences in imagery use were minor. Elite level players generally reported greater use of all functions of imagery (i.e., CG, CS, MG, MS) compared to non-elite players. And finally, regardless of ability level, motivational general imagery was used the most frequently.

Sport Imagery Questionnaire (SIQ). While the IUQ for Soccer Players advanced our knowledge regarding imagery use by athletes, and especially why they use imagery, its chief limitation is that the items on the questionnaire are soccer specific. Hall, Mack, Paivio, and Hausenblas (1998) developed the SIQ to examine why athletes, regardless of sport, use imagery. This questionnaire was developed based on the assumption that the functions of imagery are orthogonal. That is, when individual differences in imagery use are assessed, all possible combinations of the functions of imagery use should emerge.

The first stage in the development of the SIQ was to assess the motivational and cognitive functions of imagery (i.e., CG, CS, MG, and MS). Items were developed for the SIQ based on Paivio's (1985) model, constitutive definitions, reviews of the sport psychology and cognitive psychology literature, and reviews of other inventories assessing imagery use. Content validity was assessed by researchers in sport and cognitive psychology. Initially, 46 items were retained, and this version was administered to 113 athletes from a variety of sports and competitive levels, during practice sessions. Athletes rated each item on their frequency of use on a 7-point scale, ranging from 1 = rarely to 7 = often. Results of a principal components factor analysis suggested that CG, CS, and MS items loaded cleanly on their respective subscales.

However, the MG subscale separated into two distinct factors: motivational general-mastery (MG-M), which represented images of being in control and focused, and motivational general-arousal (MG-A), which represented images of anxiety and excitement. The factor analytical techniques also supported a 30-item version of the SIQ.

The second stage in the development of the SIQ involved examination of the new 5-factor structure of the SIQ. In order to accomplish this purpose, a sorting task was undertaken with undergraduate Kinesiology students, who categorized each of the 30 items into as many subgroups as deemed appropriate. A frequency table of the participants' classifications was constructed (i.e., the number of times participants responded that item 1 represented a similar function of imagery as item 2, etc.). Again, a principal components factor analysis was conducted to determine if the 30-item version of the SIQ measured distinct factors. Support was found for this version of the SIQ, with 5 underlying factors: CG, CS, MG-M, MG-A, and MS.

The final phase in the development of the SIQ involved the assessment of construct and predictive validity. The SIQ was administered to 271 track and field athletes, and 91 hockey players of various competitive levels. The 5-factor structure of the SIQ was again supported using the same factor analytic procedures employed in the previous stages. In addition, athletes reported using imagery more for its motivational than cognitive functions. The SIQ was also able to distinguish between athletes of differing skill levels. The motivational functions of imagery predicted performance for national level athletes, while the cognitive functions of imagery predicted performance for high school athletes.

Hall et al. (1998) subjected the SIQ to only exploratory factor analytic procedures. Further psychometric analysis of the instrument using confirmatory factor analytic procedures was warranted. Therefore, Stevens, Short, and Hall (2005) recently undertook a study to assess the factorial validity of the SIQ across a large and diverse sample of athletes using confirmatory factor analytic (CFA) procedures. The sample was comprised of 1293 participants representing 22 sports. The athletes competed at one of five levels: recreational athletes (43% of the sample), local (19.6%), varsity (27%), provincial (4.6%), and national (1.5%). All participants were over the age of 16.

Athletes' responses to the SIQ were subjected to a CFA of the hypothesized underlying factor structure, using ML procedures that assume a multivariate normal distribution. Various fit indices were selected in order to assess the adequacy of fit of the model: NNFI, CFI, GFI, and RMSEA. For the NNFI, CFI, and GFI, values of .90 or higher are desirable. For RMSEA, values less than or equal to .05 represent a close fit of the sample to the population, and values less than or equal to .08 represent a reasonable fit. The indices used to assess goodness-of-fit demonstrated a satisfactory fit of the model: NNFI = .91, CFI = .90, GFI = .89, and RMSEA = .06. In addition, the internal consistency of the SIQ subscales was calculated via coefficient alpha. The SIQ subscales showed acceptable reliability (CG = .81, CS = .83, MG-M = .85, MG-A = .81, and MS = .90). These results and a slightly modified (improved) version of the SIQ appear in a recent publication by Hall, Stevens, and Paivio (2005).

Research using the SIQ has yielded important information regarding athletes' use of imagery. For example, Moritz, Hall, Martin, and Vadocz (1996) found that high sport confident athletes used more MG-M imagery than did low sport-confident athletes. In addition, MG-M imagery accounted for 20% of the variance in the State Sport Confidence Inventory (Vealey, 1986) scores of the athletes. Also, Vadocz, Hall, and Moritz (1997) found that MG-A imagery significantly predicted cognitive state anxiety, indicating that this function of imagery may be useful in controlling anxiety levels. Martin, Moritz, and Hall (1999) have developed a model of imagery use in sport taking into account these and other studies examining the five imagery functions assessed by the SIQ. A major tenant of the model is that the function of imagery used by athletes must match the outcome that is desired. For example, if athletes want to develop, maintain, or regain self-confidence, they should use MG-M imagery, whereas if they wish to learn and improve specific skills, they should employ CS imagery.

Through the development of questionnaires assessing imagery use in sport, significant progress has been made in understanding athletes use imagery, and how imagery may influence performance in the sport domain. However, imagery may be used in other physical activities settings as well, and it is these settings we will examine next.

Measuring Imagery Use in Exercise

While considerable research has investigated the use of imagery in sport, significantly less research has examined the role imagery may play in exercise. Hall (1995) first proposed that exercisers might use imagery related to their physical activity. Hausenblas et al. (1999) conducted the initial study investigating the nature of imagery use by exercisers. They found that over 75% of aerobic exercise participants used exercise imagery with moderate frequency. Responding to open-ended questions regarding their imagery use, participants indicated that they imaged themselves exercising for a variety of reasons such as relieving stress, to look and feel good, and to practice their exercise activities (e.g., routines).

Exercise Imagery Questionnaire – Aerobics Version (EIQ – AV). Based on the above information, Hausenblas et al. (1999) developed the EIQ – AV in order to assess why exercisers use imagery. The initial version of the EIQ – AV was comprised of 23 items rated on a 9-point scale ranging from 1 = never to 9 = always. This version was administered to 307 aerobics participants. Principal components analysis with varimax rotation was conducted. Three factors emerged accounting for 63.8% of the variance. The first factor was comprised of five items relating to mood enhancement. The second factor was made up of five items related to health and appearance. The third factor consisted of four items representing cognitive components.

The next phase of the study involved administering the 14-item version of the EIQ – AV to 171 aerobics participants. Principal components analysis with varimax rotation was again employed, and a three-factor solution emerged. The three scales were labeled health and physical appearance (3 items), mood enhancement (3 items), and cognitive function (3 items), and together they accounted for 67.7% of the variance. Internal consistencies ranged from .84 - .85. Hausenblas et al. examined the construct validity of the EIQ –AV by looking at differences in imagery use based on frequency of exercise. High frequency exercisers used all three functions of imagery more than did low frequency exercisers, further lending support for the psychometric properties of the EIQ – AV.

Exercise Imagery Questionnaire (EIQ). An obvious limitation of EIQ – AV is that it is specific to aerobics. Therefore, Rodgers, Hall, Blanchard, and Munroe (1999) developed a more general form of the

EIQ that was applicable to other forms of exercise. This is a 9-item measure on which participants rate their use of imagery on a 9-point scale anchored by 1 = never and 9 = always. It is comprised of three functions (subscales) labeled appearance, energy (both of these are motivational functions), and technique (cognitive function). The three functions have been supported by confirmatory factor analysis. The fit indices suggested excellent model fit (RMSEA = .05, GFI = .93, CFI = .99). Reliabilities for this version have been satisfactory, ranging from .87 - .90.

Gammage et al. (2000) utilized the EIQ to investigate how imagery use varied with gender, frequency of exercise, and exercise type. Exercisers used appearance imagery the most, followed by technique and energy imagery. More frequent exercisers used all three types of imagery more than less frequent exercisers. Furthermore, gender and activity differences emerged. Men used more technique imagery than did women, while women used more appearance imagery than did men. Runners used less appearance imagery than individuals who were weight trainers, aerobics participants, or those who used cardiovascular equipment. Also, weight trainers used more technique imagery than the other three groups. However, it was noted that these results should be interpreted with some caution, given the relatively small sample sizes on which they were based. Nonetheless, these results indicated that, like their sport counterparts, exercisers do use imagery for motivational and cognitive purposes.

Exercise Imagery Questionnaire – Weight Training (EIQ-WT). Munroe-Chandler, Kim, and Gammage (2004) investigated the use of imagery by weight-trainers. However, given the specific nature of this group of individuals, and the differences in imagery use between weight trainers and exercisers engaged in other types of physical activity (Gammage et al., 2000), these authors adapted the generalized version of the EIQ to be more specific to the weight training environment. The EIQ-WT also contains nine items across three subscales. However, instead of referring to general exercise, this version refers specifically to imagining lifting weights (e.g., "I imagine a more 'defined-me' from lifting weights"). Initial reliability co-efficients for this scale in men were adequate, with values ranging from .79 to .84. More recently, this scale has also been used with male and female weight lifters, and again has

demonstrated satisfactory reliability co-efficients, ranging from .69 - .90 (Munroe-Chandler, Gammage, & Hall, 2005).

Despite the valuable information gained about exercise imagery from general and activity specific versions of the EIQ, it has been suggested that the three subscales (appearance, technique, energy) may not fully capture the functions of imagery use in exercise (Gammage, 2001).

Exercise Imagery Inventory (EII). In 2003, Giacobbi, Hausenblas, Fallon, and Hall conducted a series of semi-structured interviews with female exercisers, to examine more in-depth how and why exercisers used imagery. Based on these interviews, they described several functions of imagery in exercise, which they reduced to eight higher order themes: exercise technique, aerobics routines, exercise context, appearance images, competitive outcomes, fitness/health outcomes, emotions/feelings associated with exercise, and exercise self-efficacy. These higher order themes suggested that there may be some functions of imagery not captured by the EIQ.

Consequently, Giacobbi, Hausenblas, and Penfield (2005) developed the Exercise Imagery Inventory (EII) as a measure of the functions of exercise imagery. An initial pool of 41 items was developed from Giacobbi et al.'s (2003) framework of exercise imagery. These items were assessed on a 7-point Likert scale ranging from 1 = rarely and 7 = often, to indicate the frequency of use of each function of imagery. The first sample of participants included 504 undergraduate exercisers and non-exercisers. Exploratory factor analysis yielded a 19-item solution across four related factors: appearance/health imagery, exercise technique, exercise self-efficacy, and exercise feelings. Alpha co-efficients for the subscales ranged from .72-.86.

In phase 2, the validity of the 19-item version of this questionnaire was assessed using confirmatory factor analytic procedures. Participants included 509 undergraduate students who completed the 19-item version of the EII. Two models were examined: a 4-factor version as described in the first phase of their research, as well as a 5-factor version that separated the appearance/health imagery subscale into two separate factors. Results revealed that both 4-and 5-factor versions of the scale demonstrated a reasonable fit to the data, with a correlation of .98 between the appearance and health subscales.

The third phase of the research examined the factorial validity of both 4-and 5-factor models in a sample of 724 men and women aged 18-86 years. Similar fit indices to the second phase of the research were found for both the 4- and 5-item versions. The authors concluded that, given the similarity of the results of CFA procedures for the two versions as well as the high correlation between the health and appearance factors, the 4-factor version was supported, as it presented a more parsimonious model, with little gained by separating appearance and health factors. The authors also suggested, however, that in certain samples it may be useful to separate this subscale into two separate factors.

Finally, these authors also found some support for the convergent validity of the EII. There were small to moderate correlations between exercise behaviour and appearance/health imagery as well as exercise behaviour and exercise feelings. In addition, there were also moderate correlations between a measure of barriers self-efficacy, and three subscales of the EII (appearance/health, technique, and exercise self-efficacy). They concluded that individuals who exercise more and who have higher confidence in their ability to overcome barriers to exercise were more likely to use exercise imagery.

Imagery Use During Injury Rehabilitation

Recently, interest in the role that imagery plays in athletic injury rehabilitation has led to the development of a measure to assess how athletes use imagery while injured. Sordoni, Hall, and Forwell (2000) developed the Athletic Injury Imagery Questionnaire (AIIQ) in order to determine whether athletes use motivational and cognitive imagery during athletic injury rehabilitation. They developed the questionnaire based on a review of the imagery literature and other imagery use questionnaires (e.g., the SIQ). They then administered it to 71 athletes from a wide variety of sports. Each athlete was currently receiving physiotherapy treatment, and all athletes had received at least five treatments, thus allowing them sufficient opportunity to employ imagery strategies.

The AIIQ consists of both motivational and cognitive imagery items. All items are rated on a 7-point scale ranging from 1 = never to 7 = frequent. A maximum likelihood factor analysis with varimax rotation

was conducted. The results yielded two factors, labeled motivational imagery (5 items) and cognitive imagery (5 items). Internal consistency for the motivational items was .73, and for the cognitive items was .84. The results indicated that athletes used imagery less during rehabilitation than during training and competition. However, the use of imagery during injury rehabilitation was positively related to previous use of imagery in training and competition. No differences in imagery use during rehabilitation were found based on competitive level, proximity of next competition, or time in rehabilitation.

Athletic Injury Imagery Questionnaire – 2 (AIIQ-2). Sordoni, Hall, and Forwell (2001a) recently revised the AIIQ. The primary change was the inclusion of items designed to reflect healing imagery, which were developed based on the rehabilitation literature. For example, one item involves imagining your injury repairing itself. A total of 217 athletes responded to the AIIQ-2 during their physiotherapy appointments. A maximum likelihood factor analysis with varimax rotation was conducted to determine if there were three independent factors underlying the AIIQ-2. Eleven items were retained, representing three independent factors: motivational (3 items), cognitive (4 items), and healing imagery (4 items). Reliability co-efficients for the three subscales ranged from .82 to .91.

In addition to supporting the incorporation of a healing function in the AIIQ-2, Sordoni et al. (2001a) found that injured athletes used a moderate amount of imagery, and used all three types of imagery with about equal frequency. Similar to Sordoni et al. (2000), it was found that previous use of imagery in sport and rehabilitation was positively related to current rehabilitation imagery use. Also, motivational and cognitive imagery use were positively related to length of time in rehabilitation. Finally, females used more healing imagery than males. The authors concluded that the AIIQ-2 provided a reasonable measure of imagery use (motivational, cognitive, and healing) in injury rehabilitation.

Where Do We Go from Here? Future Directions in Measuring Physical Activity Imagery

Imagery has been extensively investigated in sport for many years, and more recently has been examined in exercise and athletic injury

rehabilitation. Interest in the role imagery may play in these physical activity settings has led to the development of various imagery measures (see Table 1 for a summary of all measures). Early research in sport

Table 1 : Summary Table of the Measurement Instruments Used in Sport and Exercise Psychology

Instruments	Characteristics of the Measurement Instruments			
	Setting	Attribute	# of Items	Psychometrics
VVIQ	General	Ability	16	Reliability Validity
MIQ	General	Ability	18	Reliability Validity
VMIQ	General	Ability	24	Reliability Validity
MIQ-R	General	Ability	8	None
MIAMS	Sport	Ability	16	Reliability Validity
PSIS	Sport	Use	45	Reliability* Validity*
IUQ	Sport	Use	37	None
IUQ for Figure Skating	Sport	Use	37	None
IUQ for Rowing	Sport	Use	41	None
IUQ for Soccer Players	Sport	Use	47	Reliability Validity
SIQ	Sport	Use	30	Reliability Validity
EIQ-AV	Exercise	Use	14	Reliability Validity
EIQ	Exercise	Use	9	Reliability Validity
EIQ-WT	Exercise	Use	9	Reliability
EII	Exercise	Use	19	Reliability Validity
AIIQ	Injury Rehab	Use	10	Reliability Validity
AIIQ-2	Injury Rehab	Use	11	Reliability Validity

Note: * = problems reported with reliability/validity for this instrument

focused on two issues: the role of cognitive specific imagery in learning motor skills and the measurement of imagery ability.

The former was assessed by experimental procedures while the latter was assessed through the development of questionnaires such as the VMIQ, MIQ, and more recently the MIAMS. These instruments have provided valuable information regarding whether high imagers have an advantage over low imagers in learning and performing sport-related skills. Moreover, one of the most important contributions of these instruments has been their use in controlling for individual differences in imagery ability when other imagery manipulations are undertaken in research studies.

While these instruments have made significant contributions to imagery ability research, improvements in the measurement of imagery ability are certainly possible. The VMIQ, MIQ, and MIQ-R assesses imagery ability related to general movement, and in many research and applied situations it would be preferable to have specific measures (e.g., a measure of the ability to image jumps in figure skating).

In the past 10 years, researchers have shifted their focus from cognitive specific imagery to the other functions that imagery can serve. Accordingly, various instruments have been developed in order to assess both the cognitive and motivational functions of imagery in physical activity settings. Today, the most widely used instrument in sport is the SIQ. The SIQ assesses five functions of imagery, CS, CG, MS, MG-M, and MG-A. However, there are likely other functions of imagery the SIQ fails to measure (Munroe, Giacobbi, Hall, & Weinberg, 2000). For example, imagery may be used by athletes for distraction control. Therefore, refinement of the SIQ is likely to be required as we attempt to understand more about why athletes use imagery.

With respect to the use of imagery in other physical activity domains, the development of the EIQ has allowed researchers to begin to understand how imagery functions in an exercise setting. However, future research must continue in this area. While three functions of exercise imagery have been identified using the EIQ, subsequent research has uncovered other functions, including self-efficacy, and feelings (Giacobbi et al., 2005). It is possible that still other functions exist, such as boredom relief, or imaging training plans (Gammage, 2001). Further refinement of these instruments may also enable researchers to better investigate possible

moderators of the exercise imagery-behavior relationship, such as gender, type of exercise, stage of exercise participation, and imagery perspective.

Imagery research has also begun to investigate the use of imagery during injury rehabilitation. While this research is still in its infancy, early work suggests that imagery serves three functions in injury rehabilitation: motivational, cognitive, and healing. However, further work is required. For example, interviews with professional ballet dancers have suggested that in addition to cognitive, motivational, and healing functions, imagery may also serve as a distraction from pain (Sordoni, Weir, & Hall, 2001b). Sordoni (2001) also suggested that further psychometric evaluation of the AIIQ-2, including confirmatory factor analysis, is required.

In 1999, Martin et al. proposed a model of imagery use in sport, and Hall (2001) generalized this model to include exercise and injury rehabilitation settings. Martin et al. (1999) suggested that the value of the model was to develop specific hypotheses of imagery use that can be tested empirically. Ultimately, the model offers guidance in applying imagery research to consulting and interventions with athletes and exercisers. More recently, Munroe-Chandler and Gammage (2005) proposed an applied model of exercise imagery, designed to help move research and practice in this area forward. This model proposes that the imagery functions can impact both behavioral (e.g., adherence, technique) and cognitive (e.g., exercise dependence, body image) outcomes through the mediating effects of self-efficacy. However, the testing and application of these models, to a large extent, relies on the measures of imagery that exist to assess these constructs. Thus, the continued development and refinement of imagery measures continues to be an important area of research in sport and exercise settings.

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