Psychometric Properties of the Revised Movement Imagery Questionnaire (MIQ-R)

Eva V. Monsma*  Sandra E. Short†  Craig R. Hall‡
Melanie Gregg**  Phil Sullivan††

*University of South Carolina, eavadocz@mailbox.sc.edu
†University of North Dakota, sandra.short@und.nodak.edu
‡University of Western Ontario, chall@uwo.ca
**University of Western Ontario, mgregg@uwo.ca
††Brock University, psulliva@brocku.ca

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Abstract

The revised Movement Imagery Questionnaire (MIQ-R: Hall & Martin, 1997) assesses visual and kinesthetic movement imagery abilities and has become a popular questionnaire in sport and exercise psychology research. The purpose of this study was to examine the psychometric properties of the MIQ-R including internal consistency, stability, factor structure, and gender invariance. There were 325 male (n = 136) and female (n = 189) athletes/dancers who participated in the study. Gender-specific internal consistency coefficients ranged from .83 to .89 and the test-retest reliabilities over a one week period for the subscales were .80 for visual and .81 for kinesthetic imagery abilities. The best model fit from confirmatory factor analyses results was for a 2-factor structure with an interrelationship between the subscales. These results support the finding that visual and kinesthetic imagery abilities are separate but related constructs. An examination of invariance by gender indicated that the model fit females better than males.

KEYWORDS: imagery ability, gender differences, measurement
Movement imagery refers to the visual and kinesthetic properties of movements that are rehearsed mentally in the absence of overt physical movement (Hall, 2001). Using imagery has been shown to benefit motor skill acquisition and performance enhancement in movement contexts such as sports training and competition, the performing arts (for reviews see Cumming & Ramsey, 2009; Martin, Moritz & Hall, 1999) and rehabilitation settings (e.g., Gregg, Hall & Butler, 2007; Monsma, Mensch & Farrol, 2009). More specifically, the ability to visually and kinesthetically image physical movements is a factor that differentiates between successful and less successful athletes (for a review see Krane & Williams, 2006).

Visual and kinesthetic sensory components of imagery have been extensively studied in imagery research. The ability to image along these modalities is a feature of Martin et al.’s (1999) applied model of mental imagery for sport which has guided imagery research for the last decade. A premise of this model is that individuals with greater capacities to generate movement imagery will experience greater learning and performance-related benefits. That is, movement imagery ability moderates, and perhaps mediates, the relationships between the functions of imagery used in various sport contexts (e.g., training, competition and rehabilitation) and the desired outcomes (e.g., acquisition and improved performance of skills and strategies, modification of cognitions, and regulation of arousal and anxiety). Similarly, Cumming and Ramsey (2009) noted that athletes with low imagery abilities are less likely to benefit from imagery interventions. They suggested using imagery ability measures as screening tools so that researchers have information on their participants’ experience with and knowledge of imagery.

Multiple questionnaires have been developed to assess movement imagery ability but few focus on the visual and kinesthetic modalities. The original version of the Movement Imagery Questionnaire (MIQ; Hall, Pongrac, & Buckolz, 1985) was developed in response to equivocal findings questioning whether imagery ability influences performance gains in motor skill acquisition. Hall and colleagues argued that inconsistent results were due to inadequate assessment instruments. At that time, existing instruments involved visual imagery ratings of people, places and scenes that had little relevance in movement contexts. The MIQ is an 18-item questionnaire that entails physically performing 9 movements, then visually and kinesthetically imaging those movements followed by rating the ease or difficulty of generating those self-images on a 7-point Likert scale (where 1 = easy and 7 = difficult).

In terms of the reliability and validity of the MIQ, stability coefficients of the English (Hall et al., 1985), French (Lorant & Gaillot, 2004) and Spanish (Atienza, Balaguer & Garcia-Merita, 1994) versions are adequate (> .80 over one to three week intervals). Both exploratory and confirmatory factor analyses show...
that the visual and kinesthetic subscales of the MIQ are separate, but related constructs. For example, Atienza et al. (1994) explored the bi-factorial structure and reliability of the MIQ in a small sample \((N = 110)\) of male and female Spanish undergraduate and high school student non-athletes 14 to 31 years of age. Similarly, Lorant and Gaillot (2004) confirmed a bi-factorial structure with a sample of 127 male and female French athletes 15 to 34 years of age. While these results are promising, the samples are less than considered adequate for this type of research (small models may yield skewed distributions).

To improve the efficiency of the MIQ administration, Hall and Martin (1997) revised the Movement Imagery Questionnaire (MIQ-R) by removing some items that were frequently omitted by participants because they were too difficult to perform. Additionally, the Likert scale was reverse coded so that higher scores reflected higher imagery abilities. The MIQ-R contains 4 visual and 4 kinesthetic items that are summed to represent total visual and kinesthetic movement imagery abilities, respectively. Psychometric properties of the MIQ and the MIQ-R have been consistently adequate with Cronbach (1951) alpha coefficients ranging above .79 for both visual and kinesthetic scales (Abma, Fry, Li & Relyea, 2002; Atienza et al., 1994; Hall et al., 1985; Vadocz, Hall, & Moritz, 1997). The bi-factorial structure of the French translation of the MIQ-R has also been confirmed among a small sample of 134 male and females, 17 to 60 years of age but this sample included a composite of non-athletes and recreational athletes (Lorant & Nicholas, 2004). More recently, Gregg et al. (2007) developed a rehabilitation version of the MIQ-R specific for use with upper extremities (i.e., MIQ-RS) showing a strong relationship with the MIQ-R, adequate internal consistency, bi-factorial structure and stability.

The predictive utility of the MIQ and MIQ-R have been demonstrated indicating that good movement imagers need fewer trials to learn movement patterns (Goss, Hall, Buckolz & Fishburne, 1986) that imagery abilities can improve with practice (Rodgers, Hall & Buckolz, 1991) and that higher visual imagers experience lower cognitive anxiety, while kinesthetic imagery ability differentiates successful performers from those who are less successful (Monsma & Overby, 2004; Moritz, Hall, Martin & Vadocz, 1996; Vadocz et al., 1997). In addition, both athlete and non-athlete participants tend to show higher visual than kinesthetic imagery abilities (Atienza et al., 1994; Fishburne & Hall, 1987; Goss et al., 1986; Hall & Martin, 1997; Lorant & Nicholas, 2004).

For decades, gender has been of interest to mainstream imagery researchers and it has aroused considerable debate (see Koslow, 2004). There is some evidence that males and females may differ in their imagery generating capabilities (Ozel, Molinaro & Larue, 2001; Richardson, 1995; Taktek, 2004). For example, while females report higher visual imagery ability means than males in some MIQ studies (Atienza et al., 1994; Goss, Hall, & Buckolz, 1983), in other
studies employing the MIQ-R no gender differences are apparent (Abma et al., 2002; Lorant & Nicholas, 2004; Vadocz et al., 1997). Researchers have yet to consider gender specific MIQ-R item response patterns. Factor structures of questionnaires may differ for males and females which would mean that gender differences may reflect a difference in the interpretation of the items as well as systematic differences in ratings/factor scores.

Thus, the aim of this study was to examine the factor structure and stability of the MIQ-R including analysis of gender invariance. Although the factor structure of the French version of the MIQ-R has been confirmed among adult participants, the systematic factor structure confirmation of the English version of the MIQ-R with a representative sample of athletes stands to benefit imagery research.

Method

Participants

Three hundred and twenty-five male \((n = 136)\) and female \((n = 189)\) participants representing track and field (36.9%), skiing (11.7%), cross country (3.7%), golf (3.4%), football (2.2%), basketball (2.1%) and ballet (40%) with at least three years of competitive experience took part in the study. Ballet dancers were included in the study because, as in sport, movement imagery is relevant to learning and performance (Nordin & Cumming, 2006). The mean age of the participants was 20.2 ± 8.48 years (range: 12 to 69 years) and those who were used in the test-retest portion of the study \((n = 84)\) were from these same activities.

Measure

The MIQ-R is an 8-item self-report inventory designed to assess visual and kinesthetic imagery ability. Only four different movements are included in the MIQ-R, and each movement is rated on both the kinesthetic and visual subscales. Completing an item on the MIQ-R requires several steps. First, participants are asked to assume a starting position (e.g., standing erect with both arms at their sides). Then, participants are instructed to perform one of four simple motor movements (e.g., raising their right leg; moving their arm; jumping in the air; bending at the waist). Participants are then instructed to re-assume the starting position, and to either “see” or “feel” them self performing the movement that they just performed without actually doing the movement a second time. Participants then assign a value from a 7-point scale (where 1 = hard to image and 7 = easy to image), which indicates the ease or difficulty with which the
movement was seen/felt. Responses are summed per scale, thereby resulting in two scores, one for visual imagery ability and one for kinesthetic imagery ability. Subscale scores can range from 4 to 28.

**Procedure**

Approval to conduct this study was obtained by the appropriate Institutional Review Boards. All participants were asked to participate in this study during their regularly scheduled practices with the exception of ballet dancers who completed the MIQ-R at an audition site (Monsma & Overby, 2004). An investigator explained the purpose of the study (i.e., learning more about imagery ability), and then read the consent form to the participants. All consenting individuals completed the MIQ-R in a group format. This procedure has been used in other studies (Moritz et al., 1996; Short & Short, 2002; Vadocz et al., 1997). In the group administration, each item of the MIQ-R was read to the participants by one of the investigators. All items were completed in the order that they appear on the questionnaire. Administering the MIQ-R in this group format took approximately 10 to 15 minutes (the same time it takes for participants to complete the questionnaire individually). The same procedure (except for reading the consent form) was followed for those individuals who participated in the re-test portion of this study conducted one week later.

**Results**

**Descriptive Statistics**

The assumptions of multivariate data analysis including distribution of variables, multivariate normal distribution of variables within cases, and an examination of multicollinearity in the data set (Tabachnick & Fidell, 2007) were examined. Table 1 shows the descriptive statistics for all eight items of the MIQ-R. Scores for 5 of the 8 items were not normally distributed; they were moderately negatively skewed and displayed moderate positive kurtosis. Thus, each was transformed to the square root of their original value to uphold the normal distribution. This method of transformation has been suggested as an appropriate way to deal with variables that are measured on an arbitrary scale (Tabachnick & Fidell, 2007). With respect to the multivariate normal distribution of variables within cases, scores for the items from five participants were multivariately non-normal, as indicated by significant ($p < .001$) scores on Mahalanobis distance. These cases were eliminated from further analysis. Finally, there was no multicollinearity in the data set ($r > .80$), as correlations between items in the final data set (including the five transformed variables) ranged from .33 to .72.
A one-group \( t \)-test indicated that visual imagery ability (\( M = 24.16 \pm 3.80 \)) was higher than kinesthetic imagery ability (\( M = 22.54 \pm 6.06 \)) (\( t (324) = 5.72, p < .001 \)). The moderate correlation between the two scales indicated that the two constructs were related but distinct (\( r = .56, p < .001 \)). Two independent \( t \)-tests conducted to examine gender differences showed that males and females did not differ in their total visual (males: \( M = 24.12 \pm 3.84 \); females: \( M = 24.20 \pm 3.76 \)) or kinesthetic (males: \( M = 22.12 \pm 5.08 \); females: \( M = 22.96 \pm 7.04 \)) imagery ability scores (\( p > .05 \)).

Table 1. 
**Descriptive Statistics of MIQ-R items.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>( M )</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kin1*</td>
<td>5.61</td>
<td>1.42</td>
<td>-1.30</td>
<td>1.40</td>
</tr>
<tr>
<td>Kin2</td>
<td>5.75</td>
<td>1.37</td>
<td>-1.10</td>
<td>0.66</td>
</tr>
<tr>
<td>Kin3</td>
<td>5.56</td>
<td>1.46</td>
<td>-0.99</td>
<td>0.40</td>
</tr>
<tr>
<td>Kin4</td>
<td>5.68</td>
<td>1.44</td>
<td>-1.25</td>
<td>1.15</td>
</tr>
<tr>
<td>Vis1*</td>
<td>5.99</td>
<td>1.13</td>
<td>-1.39</td>
<td>2.47</td>
</tr>
<tr>
<td>Vis2*</td>
<td>6.04</td>
<td>1.09</td>
<td>-1.33</td>
<td>1.85</td>
</tr>
<tr>
<td>Vis3*</td>
<td>6.07</td>
<td>1.21</td>
<td>-1.45</td>
<td>1.85</td>
</tr>
<tr>
<td>Vis4*</td>
<td>6.06</td>
<td>1.17</td>
<td>-1.67</td>
<td>2.92</td>
</tr>
</tbody>
</table>

*Notes.* Items scored on a scale of 1 – 7, with higher scores indicating greater imagery ability.

*These items were found to be non-normally distributed and were transformed to the square root of their original value for subsequent analyses.

**Internal Consistency and Test-Retest Reliability**

For the total sample, Cronbach (1951) alpha coefficients were .84 for the visual subscale and .88 for the kinesthetic subscale. By gender, the alpha coefficient for the visual subscale was .85 for females and .83 for males and for the kinesthetic subscale was .89 for females and .88 for males. The one-week interval test-retest reliability coefficient, derived from a reduced sample (\( n = 86 \)), was .80 for visual imagery ability and .81 for kinesthetic imagery ability. By gender, female and male test-retest reliability for the visual subscale was .82 and .78, respectively and for the kinesthetic subscale was .81 for both males and females.
Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) was conducted through EQS (Bentler, 1995). All analyses were based on the covariance matrix and used Maximum Likelihood (ML) estimation. The initial model included four items for each of the factors of visual and kinesthetic imagery. This model produced poor results: Comparative Fit Index (CFI) $FI = .90$, Non-Normed Fit Index (NNFI) $= .90$, Adjusted Goodness of Fit Index (AGFI) $= .82$, Standardized Root Mean Residual (SRMR) $= .28$, Root Mean Square Error of Approximation (RMSEA) $= .15$. Typically, accepted standards for an excellent fit of the model to the data are global fit indices greater than .95, SRMR less than .06 and a RMSEA less than .10 (Bentler, 1995). The model was then modified to include a path between the two first order factors because previous research (Abma et al., 2002; Vadocz et al., 1997) and theory (Paivio, 1986) suggest these two factors are interrelated, and such a path in CFA allows for this interrelationship. This second model resulted in a significant improvement in the fit of the data ($\Delta \chi^2 (1) = 126.14, p < .001$). This model showed excellent fit between the data and the model (CFI $= .99$, NNFI $= .96$, AGFI $= .95$, SRMR $= .03$, RMSEA $= .06$).

Gender Invariance

Because previous research has indicated gender differences for other movement imagery ability measures and the present sample included relatively large numbers of males and females, an analysis of invariance was conducted to see if the same factor structure was sustained across both samples (i.e., males and females). CFA’s were conducted independently for the samples of male and female athletes. Whereas the female sample showed good fit to the model (CFI $= .98$, NNFI $= .96$, SRMR $= .03$, RMSEA $= .01$), the data failed to converge to the model with the male sample. Thus, parameters were tested for invariance (i.e., factor loadings, factor variance/covariances, and error variance/covariances). Table 2 summarizes the analysis of invariance showing that although the baseline model showed acceptable fit indicators, subsequent models each showed a statistically significant difference from this baseline model. Thus, there appears to be a significant amount of variance between males and females on this factor structure.
Table 2.
Summary of Analysis of Invariance.

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$\Delta \chi^2$</th>
<th>NNFI</th>
<th>CFI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline model</td>
<td>70.60</td>
<td>38</td>
<td>70.60</td>
<td>.98</td>
<td>.98</td>
<td>.05</td>
</tr>
<tr>
<td>Factor loadings</td>
<td>289.18</td>
<td>44</td>
<td>218.58 **</td>
<td>.82</td>
<td>.82</td>
<td>.10</td>
</tr>
<tr>
<td>Factor covariance</td>
<td>289.72</td>
<td>45</td>
<td>219.12 **</td>
<td>.82</td>
<td>.82</td>
<td>.13</td>
</tr>
<tr>
<td>Factor variance</td>
<td>295.90</td>
<td>47</td>
<td>225.30 **</td>
<td>.82</td>
<td>.82</td>
<td>.13</td>
</tr>
<tr>
<td>Error variance</td>
<td>101.53</td>
<td>55</td>
<td>30.93 *</td>
<td>.96</td>
<td>.97</td>
<td>.05</td>
</tr>
</tbody>
</table>

Note. * p < .05, ** p < .001

Discussion

This study examined the internal consistency, stability, and factorial validity of the MIQ-R. It is the first known confirmatory factor analysis conducted on the English version of the MIQ-R with a sample of competitive athletes and performers that also considered gender invariance. Although the original MIQ and MIQ-R were developed with non-athlete samples, this questionnaire has received widespread attention in the sport psychology literature especially with developments in applied imagery research (e.g., Martin et al., 1999). Thus, the examination was definitely warranted.

Consistent with previous MIQ and MIQ-R studies, the Cronbach (1951) alpha coefficients for the total sample and by gender were above .80 for both visual and kinesthetic subscales. The test-retest reliability coefficients also resembled MIQ results for one-week (Hall et al., 1985) and three-week intervals (Atienza et al., 1994; Lorant & Gaillot, 2004). Unlike previous confirmatory factor analyses of the French versions of bi-factorial MIQ (Lorant & Gaillot, 2004) and MIQ-R (Lorant & Nicholas, 2004) factor structures, a path between visual and kinesthetic imagery abilities was required to demonstrate an adequate fit. Such a path might be expected between two subscales assessing imagery of the same movement pattern. Moderate correlations between the two subscales shown in MIQ and MIQ-R literature ($r = .59$ to $.66$) consistently indicate visual and kinesthetic imagery abilities are separate but related constructs (Abma et al., 2002; Goss et al., 1986; Vadocz et al., 1997). Moreover, longstanding theoretical implications have associated visual and kinesthetic perceptions as imagery properties (Jacobson, 1931; Lang, 1979; Paivio, 1986).

Visual imagery ability scores were significantly higher than kinesthetic imagery ability scores which is consistent with trends in previous samples of athletes (e.g., Abma et al., 2002; Lorant & Gaillot, 2004; Vadocz et al., 1997) and non-athletes (e.g., Atienza et al., 1994; Hall & Martin, 1997; Lorant & Nicholas,
2004). Contrary to assertions of gender differences in imagery (e.g., Atienza et al., 1994; Richardson, 1995), mean differences across gender were not significant for visual or kinesthetic MIQ-R subscales. Together with the findings of Lorant and Nicholas (2004), French and English male and females representing a broad age range do not appear to differ in movement imagery as evident in MIQ-R subscale means.

One of the most notable features of the present study was the analysis of gender invariance. Although no gender variability was revealed through internal consistency and item mean difference analyses, the model showed a better fit for data from females than for males. That is, the model as a whole, including errors and latent factors, indicates that males and females were not responding to MIQ-R items in a similar fashion. This result means that gender differences for the MIQ-R may be due to differences in the interpretation of the items. Accordingly, researchers interested in employing the MIQ-R may want to collect sufficient data enabling separate statistical analyses by gender. Merging samples across gender may compromise the validity of findings as any possible effects involving the MIQ-R may be attenuated because of the masking effect gender has on the model as a whole.

One limitation of this study was the breadth of sport type, age range and years of experience represented in the sample. According to Taktek (2004) such variables may influence imagery ability. While some researchers have found no relationships between age and the MIQ-R subscales (e.g., Monsma & Overby, 2004; Vadocz et al., 1997), Lavisse, Deviterne, and Perrin (2000) showed developmental variation in mental processing related to motor skill acquisition. Future investigations should examine the factor structure of youth and older athletes and replicate the gender invariance analyses particularly with a larger sample of males. While all of the participants were skilled enough to enable participation at competitive levels, experience levels assessed in terms of years has limited generalizability across the activities represented in this sample. Thus, researchers are advised to consider age and experience within sports as having possible moderating influences on more omnibus research questions.

A final point worth mentioning involves recent evidence indicating that completing questionnaires individually may compromise the reliability of responses (Short & Short, 2002). Consistent with previous investigations (Vadocz et al., 1997), the MIQ-R was administered in a group format in the present study. This method of administration should be considered to ease efficiency of data collection and more importantly improve the reliability of responses as research assistants can ensure participant’s movements are done correctly and questions are addressed.

Overall, these results provide evidence that the MIQ-R is a solid self-report movement imagery instrument that can be employed as a diagnostic tool by
practitioners and as a screening tool to test the effectiveness of imagery interventions. It can also be employed to test mediating or moderating relationships in athletic contexts such as those proposed by the applied model of mental imagery (Martin et al., 1999).

References


