Original Article

Reliability and Validity of the Turkish Version of the Movement Imagery Questionnaire-3: Its Cultural Adaptation and Psychometric Properties

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ABSTRACT

Objective: Motor imagery (MI) is the mental representation of a movement without any body movement, and it has been recently used as a therapeutic intervention in rehabilitation. The Movement Imagery Questionnaire-3 (MIQ-3) is the most recent, modified version of the MIQ-revised, second edition, which is commonly used to measure the imagery ability of patients with movement dysfunction. The purpose of the study was to translate the MIQ-3 into Turkish and evaluate its test and retest reliability and validity for the Turkish-speaking population. **Methods:** Among 185 healthy participants, 181 completed the procedures. The questionnaire was applied to 86 participants with 1-week interval to evaluate internal consistency and test–retest reliability. The construct validity of the MIQ-3 was tested by confirmatory factor analysis (CFA). **Results:** The internal consistency of the Turkish MIQ-3 was satisfactory (Cronbach's alpha was 0.87 for test and 0.86 for retest reliability). The internal consistency of subscales for test–retest reliability (internal visual items, external visual items, and kinesthetic items) was 0.73–0.68, 0.74–0.72, and 0.79–0.73, respectively. Test–retest reliabilities of each item ranged from 0.84 to 0.95. In terms of criterion validity, there was an excellent correlation between subscales and total scale correlations, which ranged from 0.50 to 0.90 ($P < 0.001$). The validity of the MIQ-3 was examined with CFA, and the results supported a three-factor model of movement imagery ability. **Conclusion:** The Turkish MIQ-3 has an excellent reliability and good-to-excellent validity in evaluating MI ability.

KEYWORDS: *Imagery, reliability, validity*

INTRODUCTION

Motor imagery (MI) is the simulation of the movement in the mind, and it is also defined as a perception-like process without any external stimulus input.[1] It has a neuronal process involving specific brain structures[2,3] related with the motor, sensory, and emotional areas.[4] Mental simulation theory explains that MI and motor execution have similar brain activation while performing or imagining the same movement.[5] Furthermore, in the way of time of duration, actual movement and imaginary have similar properties.[6]

MI is generally determined with two strategies: visual and kinesthetic imagery.[7] Visual MI refers the ability of seeing an object or a movement in the mind,[8,9] is usually static, and reflects the third-person perspective.[10] Otherwise, kinesthetic MI depends on dynamic interaction of the individual, movement, and environment and indicates the "feeling" of a movement.[11] That is why, this type of imagery is related with somatosensory feelings of the movement. In addition, internal visual imagery is determined as the one's imagining from either the first person's

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perspective (kinesthetic or visual) and external visual imagery from the third person's (visual) perspective.

MI ability has been recently used in several rehabilitation approaches in patients with physical disabilities.[12] It is important to assess the ability of the MI in patients when determining if they meet the criteria for a rehabilitation program including imagery practices. Imagery questionnaires are relevant tools to determine the imagery ability of a patient in the clinical settings due to their relative ease of use. The Movement Imagery Questionnaire (MIQ) (1983) is the first reliable tool developed by Gregg *et al.*[13] and used in different populations.[14] This questionnaire was shortened from 18 items to 8 items and renamed: MIQ-revised (MIQ-R) (1997). These questionnaires are suitable for able-bodied individuals. Therefore, these questionnaires are not appropriate for people with physical limitations.[15] The MIQ-R, second edition (MIQ-RS) (2010) was adapted from MIQ-R.[13] The MIQ-3 (2012) is the last modified version of the MIQ and MIQ-R. This questionnaire has 12 items and aims to assess an individual's ability to imagine movements using different types of the imagery. The MIQ-3 has good psychometric properties in the way of the internal reliability and predictive validity.[16]

There is a need to evaluate the individuals' imagery capacity with appropriate instruments in clinical settings as the MI has been often implemented into rehabilitation programs. Questionnaires have advantages with regard to collecting information in a standardized and quick way. This study was aimed to translate the questionnaire into Turkish and put forward the adaptation process.

METHODS

A cross-sectional design was used to assess the reliability and validity of the questionnaire. This study was carried out between May 2016 and January 2018. Ethics committee approved this study (GO14/569-03), and all participants were informed about the process of the study.

Participants

Healthy volunteers were recruited consecutively into the present study. Inclusion criteria for the participants in the study were: being at least 18 and not more than 65 years of age, ability to speak and understand Turkish, not having any additional orthopedic or neurological complications, and not having any limitation in mobility or movement disorder. Individuals who were not fully able to understand the questions were excluded.

One hundred and eighty-five healthy volunteers met with the inclusion criteria for the first evaluation.

One hundred and eighty-one of them completed all procedures. However, four were excluded from the study because of missing data. Among 181 participants, 53 were males (27%) and 132 were females (73%). The mean age of the participants was 21.60 ± 2.65 years.

Procedure

The process of cultural adaptation of the MIQ-3 into Turkish population was completed by following the guidelines of Beaton *et al.*[17] after getting the necessary permissions from the creators of the questionnaire. During this process, MIQ-3 questionnaire was translated from English into Turkish by two different professionals who are perfectly bilingual speakers. A single Turkish translation text was created using these two translations, which was back-translated into English by two bilingual speakers. The back-translated version was compared to the original form. Meanwhile, the back translated versions were compared to each other. The last form of the translation was evaluated by translators (who were bilingual native English speakers and Turkish speakers), a public health expert (CG, MD. PhD.), and physiotherapists.

Reliability and validity procedure

The MIQ-3 consists of 12 items in which the same four movements are physically performed and imagined three times. It contains four items pertaining to kinesthetic MI (questions 1, 4, 7, and 10); four items pertaining to internal visual MI (questions 2, 5, 8, and 11); and four items pertaining to external visual MI (questions 3, 6, 9, and 12). Each item indicates a movement to imagine. The imaging process can be made visually or kinesthetically. Lastly, participant rates the ease or difficulty of generating an image on a 7-point scale, in which 1 means "very hard to see/feel" and 7 means "very easy to see/feel." The performed actions involve the upper limbs, the lower limbs, and the body. These actions are performed in a similar way for the other two scales. A higher score shows better mental imagery ability.

In this study, the purpose of the study and how to respond to the questions were explained to the participants. If the respondents were unclear about the meaning of a question, they could ask for clarification. The questionnaire was applied in a room with the examiner present and under the conditions described in Loison *et al.*'s study.[9] The procedures of scoring the questionnaire were given as follows: the starting position was described to the participants. The movement was explained and asked them to perform it only once. After the explanation, the participants were asked to get into the starting position and imagined the movement that was just performed. Lastly, the participants rated the

clarity of the imagined movement on a 7-point ordinal scale. It took approximately 20–30 min to administer the test.

The questionnaire was applied to the participants with 1-week interval to evaluate the test–retest reliability. This method was used to determine the reliability of the scale, and the MIQ-3 was repeated for this purpose about 1-week after the first test on 86 randomized participants from among the original sample of participants. There were no significant differences between the subgroup and the study sample.

Statistical analysis

The statistical analyses were implemented by means of the IBM Statistical Package for the Social Sciences software (SPSS version 22.0; Chicago, IL, USA) with a minimal level of significance set at $\alpha = 0.05$. The calculations were implemented using arithmetic mean ± standard deviation (SD) for the variables defined by measurement and percent (%) values for the variables defined by counting. The reliability of the scores on each of the scales was assessed through comparison of the scores by calculating an intraclass correlation coefficient (ICC).[18] Internal consistency is acceptable with a coefficient >0.7, good at 0.8, and minimum and excellent when superior to 0.8.[18] Cronbach's alpha (α) was calculated for the internal consistency of the questionnaire. When this coefficient is >0.8, it is generally considered acceptable.[19,20] Construct validity of the MIQ-3 questionnaire was tested by confirmatory factor analysis (CFA). This method was used for the analysis of the inter-item correlation matrix by using LISREL software (version 8 for Windows; Scientific Software International Inc., Skokie, IL, USA). Internal consistency relates to the homogeneity of the scale and how well the items on a tool fit together conceptually.[21]

RESULTS

Adaptation

The translation procedure revealed no major problems or language-specific/cultural differences. The translation process was not difficult, and the back-translation corresponded very well to the original version. After completion, a pilot study was performed on 15 participants. This version was finalized after making consensus. The penultimate version was judged, and it performed well in field testing. No participant had a problem in completing the questionnaire.

Motor imagery scores

Table 1 shows that the overall score at retest was higher than that at test. As shown in Table 2, the lowest score was the kinesthetic MI score for the "knee lift"

movement (6.03), whereas the highest score was the external visual MI score for the "knee lift" and "waist bend" movements (both were 6.62).

Internal consistency of the Movement Imagery Questionnaire-3 (Turkish version)

The Cronbach's α coefficient regarding the whole questionnaire was 0.87 for test and 0.86 for retest. This result indicates that the internal consistency of the Turkish MIQ-3 is excellent [Table 3].

Determining the test–retest reliability of the Movement Imagery Questionnaire-3 (Turkish version)

The ICC values for each subscale were suitable and ranged from 0.60 to 0.80, suggesting a good level of reliability.[22]

Construct validity of the Movement Imagery Questionnaire-3 (Turkish version)

The three-factor structures previously proposed in the literature were tested using the LISREL structural equation-modeling program developed. Chi-square values were statistically significant ($\chi^2 = 115.60$, df = 51, $P = 0.000$). The $\chi^2/SD = 529/289 = 2.27$ value was <3; therefore, it was accepted and within good fit limits.

Correlations between the MIQ-3's subscales and its total score were investigated to further support the MIQ-3's concurrent validity. The results revealed significantly greater correlations between subscales. As shown in Table 6, all ICCs were higher than 0.70 and McDonald (ω) coefficients were higher than 0.30.[23]

Factor loadings of the Turkish MIQ-3 are shown in Figure 1. Factor loadings for the questionnaire items exceeded the value of 0.50 and were accepted as satisfactory.[24]

DISCUSSION

The MIQ-3 is the most recent form, developed by Williams *et al.* in 2012,[16] and it assesses an imagery level using internal visual imagery, external visual imagery, and kinesthetic imagery. The original form of the MIQ-3 is in English, and MIQ-3 is also available in French, German, Persian, Polish, Portuguese, and Spanish. The aim of this study was to investigate the reliability and validity of the Turkish version of the MIQ-3 questionnaire. Our results suggest that the MIQ-3 has high internal consistency. In other words, the Turkish version of MIQ-3 is found to be a reliable and valid tool.

MI is a privileged method to facilitate motor skill learning;[26] additionally, MI is suggested to be a key

Table 1: Analysis of the mean, minimum, and maximum scores of the items for test and retest (*n*=86)

Items	Scale	Test		Retest	
		Mean±SD	Minimum-maximum	Mean±SD	Minimum-maximum
1	KI	6.03±1.22	1.0-7.0	6.19±0.98	3.0-7.0
2	IVI	6.15±0.94	3.0-7.0	6.25±0.89	3.0-7.0
3	EVI	6.44±0.83	2.0-7.0	6.46±0.74	4.0-7.0
4	KI	6.18±0.99	2.0-7.0	6.36±0.83	4.0-7.0
5	IVI	6.24±1.04	1.0-7.0	6.32±0.92	2.0-7.0
6	EVI	6.28±0.92	2.0-7.0	6.35±0.81	4.0-7.0
7	KI	6.43±0.94	1.0-7.0	6.53±0.80	2.0-7.0
8	IVI	6.29±0.87	2.0-7.0	6.42±0.76	4.0-7.0
9	EVI	6.59±0.70	3.0-7.0	6.62±0.63	4.0-7.0
10	KI	6.26±0.96	2.0-7.0	6.37±0.81	3.0-7.0
11	IVI	6.54±0.81	1.0-7.0	6.59±0.68	3.0-7.0
12	EVI	6.59±0.68	2.0-7.0	6.62±0.62	3.0-7.0

IVMI: İnternal visual imagery, EVMI: External visual imagery, KMI: Kinesthetic imagery, SD: Standard deviation

Table 2: Mean scores for each movement for test and retest (*n*=86)

Scales of MIQ-3	Movements, mean±SD							
	Knee lift		Jump		Arm movement		Waist bend	
	Test	Retest	Test	Retest	Test	Retest	Test	Retest
KI	6.03±1.22	6.19±0.98	6.26±0.96	6.37±0.81	6.43±0.94	6.53±0.80	6.18±0.99	6.36±0.83
IVI	6.24±1.04	6.32±0.92	6.15±0.94	6.25±0.89	6.54±0.81	6.59±0.68	6.29±0.87	6.42±0.76
EVI	6.59±0.70	6.62±0.63	6.28±0.92	6.35±0.81	6.44±0.83	6.46±0.74	6.59±0.68	6.62±0.62

IVI: İnternal visual motor imagery, EVI: External visual motor imagery, KI: Kinesthetic motor imagery, SD: Standard deviation, MIQ: Movement Imagery Questionnaire

Table 3: Internal consistency of subscales and sum of the Turkish version of the Movement Imagery Questionnaire-3

Internal consıstency Cronbach's alpha	Test	Retest
Kinesthetic ımaginary	0.791	0.739
External visual ımaginary	0.742	0.721
Internal visual ımaginary	0.736	0.680
Sum	0.878	0.866

element of rehabilitation to improve the functions.[25,26] Because the neural process involved in imagining and performing the movement is very similar, mental practice is proposed as an effective method to improve motor skills.[27] One of the neuroimaging studies has shown abnormal responses in several cortical areas especially related with MI including the sensorimotor cortex, parietal lobe, and supplementary motor area in patients with multiple sclerosis.[26] According to their results, the vividness of imagery is not affected, but the characteristics of the MI such as accuracy and temporal organization are affected. Pijnenburg *et al.*[28] demonstrated that patients with chronic low back pain needed more time to perform a mental task. There was also a decrease in functional connectivity among the various cortical areas involved in the process of sensorimotor integration. Several studies have shown the effectiveness of MI as

a potential adjunct to physical rehabilitation in some neurological diseases such as cerebral palsy, hemiplegia, and Parkinson's disease.[1,4,29,30] MI-integrated protocols, for instance graded MI, also have a potential to gain new top-to-bottom perspective into the rehabilitation process.[31-36] Therefore, it is important to assess the MI ability of patients to determine if they meet the criteria for a specific rehabilitation program and to report the effectiveness of the imagery strategies.[37] With respect to this theoretical information and the literature, we wanted to draw attention on this issue.

Internal consistency helps to measure a single underlying concept by using multiple items.[38] The internal consistency reliability coefficients of the subscales varied between 0.79 and 0.68 [Table 4]. It was concluded that the values that were obtained were at acceptable levels and that the items on the scale were consistent with each other. In addition, these outcomes indicate that the level of homogeneity of the scale was adequate. According to Hall and Martin's study,[14] Cronbach's α coefficients of the subscales had an acceptable internal reliability (visual: α = 0.87; kinesthetic: α = 0.90) [Table 5]. Similarly, the individual item scores were close, with small variance.

The ICCs for all scores were suitable and within the range of 0.60–0.80, suggesting a good level of reliability.[22,39] The ICC between the answers of the

Table 4: Test-retest reliability for each item (*n*=86)

Items	ICC	95% CI
1	0.87	0.84-0.90
2	0.90	0.87-0.93
3	0.90	0.86-0.92
4	0.86	0.82-0.89
5	0.88	0.85-0.91
6	0.91	0.88-0.93
7	0.84	0.79-0.87
8	0.85	0.80-0.88
9	0.86	0.82-0.89
10	0.89	0.86-0.92
11	0.92	0.89-0.94
12	0.95	0.94-0.96

ICC: Intraclass correlation coefficient, CI: Confidence interval

Table 5: Confirmatory factor analysis of the three-dimensional structure of the Turkish version of the Movement Imagery Questionnaire-3. (*n*=181 participants)

Index	Referenced values	Calculated values
χ^2/df	Perfect ≤3 ≤ acceptable ≤5	2.27
RMSEA	Perfect ≤0.05 ≤ good ≤0.08	0.08
GFI	Perfect ≥0.95 ≥ good ≥0.90	0.91
AGFI	Perfect ≥0.95 ≥ good ≥0.90	0.86
CFI	Perfect ≥0.95 ≥ good ≥0.90	0.97
NFI	Perfect ≥0.95 ≥ good ≥0.90	0.94
NNFI	Perfect ≥0.95 ≥ good ≥0.90	0.96
RMR	Perfect ≤0.05 ≤ good ≤0.08	0.04
SRMR	Perfect ≤0.05 ≤ good ≤0.08	0.05

χ^2/df: Chi-squared/degrees of freedom, RMSEA: Root mean square error of approximation, GFI: Goodness-of-fit index, AGFI: Adjusted goodness-of-fit index, CFI: Comparative fit index, NFI: Normed fit index, NNFI: Nonnormed fit index, RMR: Root mean square residual, SRMR: Standardized root mean square residual

Table 6: Bivariate correlations between factors of Movement Imagery Questionnaire-3's original version and factors of the current version and internal consistency coefficients

Factor	Item	*r* (correlation to total scale)* *P*	Internal consistency coefficient
Kinesthetic imagery	K1	0.65	Cronbach's α=0.79
	K2	0.56	McDonald's ω=0.79
	K3	0.62	
	K4	0.60	
Internal visual imagery	I1	0.38	Cronbach's α=0.74
	I2	0.60	McDonald's ω=0.74
	I3	0.63	
	I4	0.53	
External visual imagery	E1	0.38	Cronbach's α=0.74
	E2	0.62	McDonald's ω=0.78
	E3	0.62	
	E4	0.57	

*Pearson's correlation coefficient. K: Kinesthetic imagery, E: External visual imagery, I: Internal visual imagery
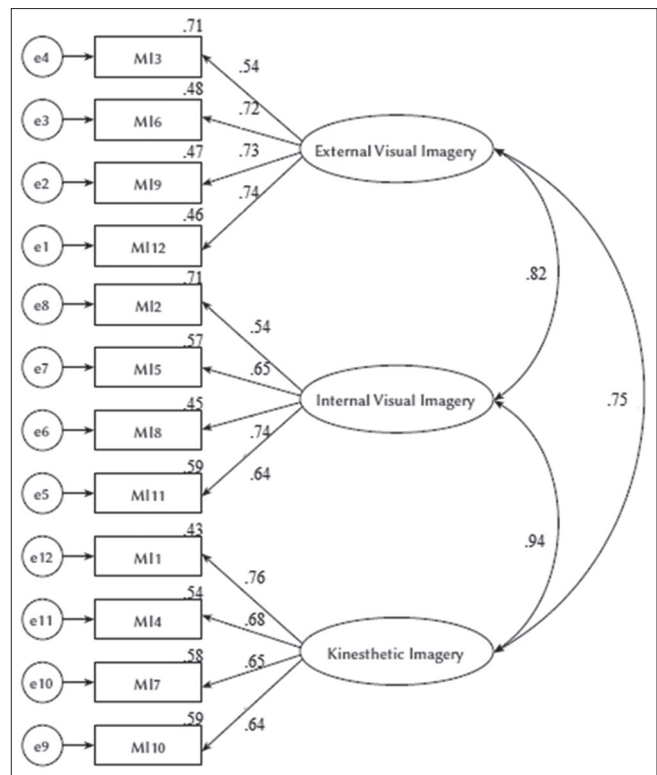
Figure 1: Factor structure of the Turkish version of the MIQ-3. Example correlated traits/correlated uniqueness model with 12 items per factor. Ellipses correspond to the three factors, IVI: Internal visual imagery, EVI: External visual imagery, KIN: Kinesthetic imagery, MIQ-3: Movement Imagery Questionnaire–3. Numbers in rectangles correspond to example items

questions in the first and second assessments of the Turkish questionnaire showed good-to-excellent test–retest reliability. ICC scores were in line with Butler *et al.*'s study. Both items of MIQ-RS were given as visual items ranging from 0.54 to 0.72 and values for the kinesthetic items ranging from 0.54 to 0.73. Similarly, the MIQ-RS was reliable over time in both the stroke and control groups (with values ranging from 0.89 to 0.95).[15]

Literature on the current topic posits various explanations for differences in subscale scores. According to our results, MI scores at retest were higher than that at test. In addition, visual MI scores were higher than kinesthetic MI scores and external visual MI scores were superior to internal visual MI scores in our study. Some studies obtained similar results related with the imagery scores.[9,14] According to Gregg *et al.*'s[13] athletes tend to be able to perform visual imagery more easily than kinesthetic imagery; this may be because they have more exposure to visual images, such as watching video of themselves performing a skill.[13] In addition, one of the factors effecting the subscale scores is experience of the players. The Polish version[40] of the MIQ-3 revealed differences of subscales in athletes according to their

experience levels, and this study showed that visual MI scores were higher in more experienced athletes.

Cronbach's α coefficient results, which were used to measure the internal consistency of the items of this questionnaire, showed that the whole questionnaire and its subscales have a desirably acceptable internal consistency. The results obtained in the present study are in line with those of Williams *et al.*'s[16] study. In the present study, Cronbach's α coefficient for the whole questionnaire was 0.87 for test and 0.86 for retest, which are both higher than the 0.80 needed to be acceptable. The validity of the MIQ-3 was examined through CFA and three-factor model (internal visual, external visual, and kinesthetic) was supported. This also demonstrated an acceptable goodness of fit, as determined in the original version. It was confirmed by high scores of model fit indices.

There were some limitations of this research. There could have been a larger sample size with a wider age range. Future researches will concern further validation of the Turkish MIQ-3. Data could be collected more systematically using different age groups and from different sports or clinical situations.

To conclude, MI is implemented into various rehabilitation approaches; it is important to use tools such as the MIQ-3 to assess the MI ability in clinical settings throughout the rehabilitation process. The results of this study represent that the Turkish MIQ-3 exhibits good reliability and construct validity.

CONCLUSION

This study presents the validated Turkish MIQ-3 for Turkish-speaking rehabilitation therapists, physical trainers, and medical doctors, who are interested in assessing MI ability.

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Conflicts of interest
There are no conflicts of interest.

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