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DERLEME / REVIEW

Motor Imagery Assesment Methods: A Narrative Review

Motor İmgeleme Değerlendirme Yöntemleri: Derleme

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Abstract

Motor imagery is the mental rehearsal of movements without revealing any movement. It is a complex phenomenon that is difficult to study, understand and explain since it requires mental planning and preparing. It is particularly challenging to evaluate to what extent movements are mentally represented. However, not everyone experiences the same level of vividness and intensity in their vision. The study procedure in this area is complicated by the fact that there are variations in people's imagery styles. Although exercises that involve motor imagery have been found to be successful in physiotherapy, there is a crucial link between imagery skill and the effectiveness of the practice. This review's objective is to provide information on the tests used in physiotherapy clinics to assess a patient's capacity to use motor imagery.

Keywords: Assessment, mental imagery, motor imagery.

Öz

Motor imgeleme, herhangi bir hareket ortaya çıkarmadan hareketlerin zihinsel provasıdır. Zihinsel planlama ve hazırlama gerektirdiği için incelenmesi, anlaması ve açıklaması zor olan karmaşık bir olgudur. Hareketlerin zihinsel olarak ne kadar temsil edildiğini ölçmek özellikle zordur. Bununla birlikte herkesin imgelemesinde aynı canlılık ve yoğunluk seviyesini deneyimlemediği göz önüne alındığında, hareketlerin zihinsel olarak temsil edilme derecesinin nicelendirilmesi özellikle zorlu bir durumdur. Bu alandaki çalışma prosedürleri, insanların imgeleme biçimlerinde farklılıklar olması nedeniyle karmaşıktır. Fizyoterapide motor imgeleme içeren egzersizler başarılı bulunmasına rağmen, uygulamanın etkililiği ile imgeleme yeteneği arasında önemli bir bağlantı bulunmaktadır. Bu incelemenin amacı, bir hastanın motor imgeleme kullanma kapasitesini değerlendirmek için fizyoterapi kliniklerinde kullanılan testler hakkında bilgi sağlamaktır.

Anahtar Kelimeler: Değerlendirme, mental imgeleme, motor imgeleme.

1. Introduction

In a dynamic mental state known as motor imagery (MI), representations of a specific motor movement are practiced in working memory without performing any movement (1,2). It is a complex cognitive process that uses sensory and perceptual processes and enables certain information to be reactivated. The mental practice that takes place during motor imagery is also defined as the symbolic rehearsal of physical activity without any gross muscle movements (3). Different terminologies such as visual imagery and mental imagery have been used in the literature for the term MI. The terms "motor imagery practice" and "mental imagery" (or mental rehearsal) are often used interchangeably. The term motor imagery will be used in this review.

Motor imagery is applied to improve motor performance and learn motor tasks. MI; is divided into two categories internal (kinaesthetic) and external (visual). When imagining, one can take a first-person (internal) or third-person perspective (external). The first-person perspective is about either one's own view of the image content or its kinaesthetic sense. The third-person perspective is the visualization of scenes outside the person. To put it another way, internal imagery is when a person imagines himself inside his own body as opposed to external imagery, which is when a person sees himself as an outside observer. The expected feelings that would occur in real life situation are experienced during internal visualization (4). Motor imagery gives people conscious access to the central nervous system and influences cortical reorganization through neuroplasticity (5,6). The three mechanisms that underpin the plasticity brought on by MI are as follows: By enhancing signal transduction, MI decreases presynaptic inhibition at the spinal level and aids in the somatotopic remodeling of cortical maps. MI also improves inter-synaptic communication at both the cortical and spinal levels (7,8).

According to published research, active movement and MI are identical from a neurofunctional aspect. Neuroimaging findings also suggest the presence of similar brain networks associated with the imagination and execution of a movement (9–11). It has been demonstrated that most of the brain regions involved in the movement, including the cerebellum, basal ganglia, and parietal and premotor cortex, are also involved in mental practice (12).

Motor imagery, as mentioned above, is a method that has been shown to be effective and is widely used in physiotherapy clinics. However, motor imagery ability differs between individuals and is multifaceted. It is thought that some patients cannot perform motor imagery and therefore cannot benefit from mental practice (1).

1.1. Use of Motor Imagery in Rehabilitation

In the latter half of the 1980s and the beginning of the 1990s, MI was applied to rehabilitation. Early research suggested that older people's balance could be improved by motor imagery (13). MI has grown in significance in the field of rehabilitation research as a result of notable advancements in the previous twenty years in the quickly developing field of brain-computer interface. As the number of recently published dynamic neuroimaging studies has increased, the use of MI for rehabilitation has become widespread.

There are studies in the literature showing that it is effective in the rehabilitation of neurological and orthopaedic diseases. Paolucci et al. showed that MI combined with mirror therapy improved the physical function of the face in patients with facial paralysis (14). When combined with traditional physical therapy, MI is helpful in patients with stroke for the functional rehabilitation of both the upper and lower limbs as well as for the restoration of daily tasks and skills (15). There is a distinct functional remodeling of brain regions associated to motor control and executive-attention skills when MI is added to Parkinson's disease dual-task gait/balance training (16). MI applied in patients with multiple sclerosis increases walking speed and distance, reduces fatigue, and improves quality of life (17). It has been shown to be more effective than routine physiotherapy in reducing phantom pain in amputees (18). It has been reported that MI applied in patients with complex regional pain syndrome provides a significant reduction in pain and swelling (19). When used effectively, MI has been found to reduce pain and pain-related impairment in patients having total knee replacement surgery for knee osteoarthritis (20). In upper extremity orthopaedic problems, MI helps relieve pain and increases shoulder mobility in people with shoulder impingement syndrome. Motor imagery is a valuable technique that can be used as a preventative tool in the progression of impingement syndrome (21).

When practical restrictions such as biomechanical limitations, physical strength limitations, pain, fatigue, injury risk, and equipment access restrictions prevent physical training, MI appears to be the ideal option (22).

1.2. Assessment Methods

Each person has a unique potential for imagination, which is multifaceted, multi-process, multi-sensory, and multidimensional (23). The individual variation of imagery complicates the research process in this area. Since the efficiency of MI is dependent on the quality of imagery, it is essential to evaluate imagery ability before performing an imagery exercise or participating in an imagery training program (24).

To create a successful method for MI assessment, it is crucial to understand its properties and aspects that can be expressed and evaluated in numbers. When evaluating imagery, there are both subjective and objective measurement methods. While objective metrics make use of behavioural, physiological, or neurological measurements, subjective approaches rely on methods like questionnaires and interviews to acquire information about MI experiences (23).

Individual responses to ordinal rating scales are often used to assess visualization ability. The most used MI evaluation methods in the field of physiotherapy and rehabilitation are discussed under 2 headings as psychometric and chronometric (25). Psychometric tests include self-report questionnaires and mental rotation methods developed to measure individual differences in image dimensions such as the vividness of imagery (clarity or sensory intensity of a mental image) and controllability, that is, the ability to see the mental image easily or accurately. For this purpose, the widely used Movement Imagery Questionnaire (MIQ) and a shorter version The Movement Imagery Questionnaire-Revised (MIQ-R) and The Vividness of Motor Imagery Questionnaire (VMIQ) have been developed. However, these are self-report questionnaires used largely in young healthy adults. Chronometric measurements, on the other hand, are based on the comparison of the time taken to perform the movement with the time taken to visualize the same movement. The duration of the activity, its complexity, the type of motor imagery (kinaesthetic and visual), and the instructions given may affect the score obtained from the chronometric measurement. It evaluates the individual's ability to maintain and control the imagined image. Chronometric measures are more objective than self-report questionnaires used to assess motor imagery but do not assess the vividness/clarity of imagery (25, 26).

1.3. Psychometric Tests

1.3.1. The Movement Imagery Questionnaire (MIQ)

This questionnaire was developed by Hall and Pongrac in 1983 to assess the ability to visualize. The scale consists of 18 items, nine of which are visual and nine are kinaesthetic, measuring in a seven-point Likert scale (27). Hall and Martin revised the psychometric properties of the questionnaire by reducing the number of items in 1997 and reorganized the questionnaire as MIQ-R because the questionnaire took a long time, and some movements were difficult to do or could not be done (28). Because neither questionnaire distinguished between internal and external perspectives, Williams et al. created the MIQ-3 (29).

1.3.2. The Movement Imagery Questionnaire-Revised (MIQ-R)

This questionnaire assesses visual and kinaesthetic movement imagery ability and consists of 8 items, four visual and four kinaesthetic. These items are; relates to gross motor function, including trunk, upper and lower extremity movements. The movement is physically done by the participant at first, followed by a visual or kinaesthetic visualization, and lastly a visual vividness score on a Visual Analog Scale (VAS) from 1 (extremely difficult to see/feel) to 7 (very easy to see/feel). Kinaesthetic imagery is assessed by questions 1, 3, 5, and 7, whereas visual imagery is evaluated by questions 2, 4, and 6. For both dimensions, an overall score is obtained that ranges from 4 to 28 (28).

Callow et al. emphasized the necessity of obtaining at least 16 points both kinaesthetically and visually for the effective implementation of the imagery intervention (30).

1.3.3. Mental Imagery Questionnaire-Revised, Second Edition (MIQ-RS)

It is the revised version of the above-mentioned MIQ-R by Gregg et al (31). It is designed to measure imageability in people with limited mobility, based on feedback from users. Two items requiring jumping (one visual and one kinaesthetic) have been removed from the MIQ-R. Because some movement problems prevent their sufferers from doing these tasks. In addition, eight items (four visual and four kinaesthetic) reflecting daily movements were added. The MIQ-RS consists of two subscales, visual and kinaesthetic, and each of them is represented by seven items. The instructions and rating scales for the MIQ-RS are the same as for the MIQ-R. This questionnaire is a reliable and valid tool for assessing MI ability in stroke populations (32).

1.3.4. The Movement Imagery Questionnaire-3 (MIQ-3)

The most recent version of MIQ and MIQ-R is MIQ-3. This 12-item questionnaire is designed to evaluate a person's capacity to visualize movements using various sorts of imagery.

Internal consistency and predictive validity are two areas where MIQ-3 exhibits strong psychometric qualities. Visual imagining skills are assessed from both internal and external viewpoints in the MIQ-3 test, which is used to gauge both visual and kinaesthetic visualization abilities. The motion image is rated twice, once for the visual image of the motion performance and once for the kinaesthetic imagery. The person imagines various movements and evaluates the degree of difficulty on a 7-point scale while doing this. The person performs all movements before visualization (29).

1.3.5. The Vividness of Motor Imagery Questionnaire (VMIQ)

The Vividness of Motor Imagery Questionnaire (VMIQ), developed by Isaac et al. in 1986, evaluates the viability of imagination in 24 items on a 5-point scale (33). Participants need to imagine each item twice: first, by imagining someone else doing the action, and second, by imagining that they did the action themselves. Thus, there are 48 responses in total. A high questionnaire score indicates poor visualization ability. Similar to the MIQ, half of the questions are answered using visual imagery, and the other half with kinaesthetic imagery. Unlike in the MIQ-3, the person does not need to perform pre-imagery movements (29). MIQ, MIQ-R, and VMIQ are mostly preferred for the assessment of imagery ability in healthy and young adult populations. Since the movements included in these questionnaires are difficult to perform, it is not suitable to be administered to people with physical disabilities (34).

1.3.6. The Vividness of Movement Imagery Questionnaire (VMIQ-2)

The VMIQ-2 is a revised version of the VMIQ designed to measure visual and kinaesthetic displays of various motor tasks. It evaluates the visualization abilities of individuals from three different aspects internal, external, and kinaesthetic while performing 12 simple motor tasks. When using internal visual images, the person sees himself/ herself performing a movement in his/her mind. When using external visual images, the person looks at his/her body from the outside and imagines performing a movement; in the kinaesthetic image, imagine how the movement feels (35).

1.3.7. Kinesthetic and Visual Imagery Questionnaire (KVIQ)

This questionnaire, created by Malouin et al. in 2007, evaluates a person's capacity for both visual and kinaesthetic visualization in both healthy and impaired individuals. The clarity of the picture and the strength of the emotion are rated on a 5-point scale. Items are simpler to do than those in MIQ and VMIQ since they include simple motions like shoulder flexion and foot tapping. Items are evaluated on a 5-point VAS of 1=very clear image or intensity, 5=no vision or no sensation. 5 points corresponds to the highest image level and 1 point corresponds to the lowest level (34).

Imagery is done from the first-person point of view. The participant is instructed to physically perform the movements before imagining them. First, the evaluator does the movement, then the participant physically performs the action. The participant is then instructed to visualize movements.

KVIQ; it has been developed for people who need guidance during imagery, cannot stand, and cannot perform complicated movements. Therefore, it is more suitable for use in individuals with physical disabilities, especially in stroke patients, compared to other scales. KVIQ is easy to administer and suitable for individuals with neuropathology. It is a valid and reliable test to evaluate motor imagery ability in Parkinson's patients. Before implementing MI as a rehabilitation technique, doctors who want to evaluate their patient’s ability to use motor imagery may find that KVIQ is a viable option (36).

There is a short and long version of this questionnaire. The abbreviated version consists of 10 items, and the long version, KVIQ-20, consists of 20 items.

1.3.8. Kinaesthetic and Visual Imagery Questionnaire -20 (KVIQ-20)

It has four steps in the evaluation process and includes kinaesthetic and visual subscales. KVIQ-20 consists of 20 elements that show the movements of various body parts. Simple head, shoulder, trunk, upper limb, and lower limb movements are included. All 10 of these exercises are done while sitting because they were chosen to be used by people with physical impairments. The KVIQ-20 also uses a five-point scale rather than a seven-point one to rate how difficult it is to perceive or sense motion and to rate the strength of sensations (Kinaesthetic subscale). 5 points corresponds to the highest image level and 1 point corresponds to the lowest level. A high score at the end of the test is accepted as an indication of good imagery level (34).

1.3.9. Kinaesthetic and Visual Imagery Questionnaire-10 (KVIQ-10)

Ten items in this questionnaire evaluate five motions from each of the visual and kinaesthetic subscales (34).

1.3.10. Group Mental Rotation Test

Participants are required to execute mental rotation tasks to test their capacity to picture how an object would appear when presented from various angles. Group Mental Rotation Test consists of 24 items to compare two-dimensional drawings of three-dimensional geometric figures. These figures are adapted from similar figures used in the literature on the concept and definition of mental rotation (37,38).

1.3.11. Chaotic Motor Imagery Assessment

The Chaotic Motor Imagery Assessment is a set of three tests that are offered in a certain order. This evaluation looks for chaotic MI, which is characterized as the inability to carry out MI correctly or, if accuracy is preserved, as a sign of temporal discrepancy.

Component 1: Hand rotation. A total of 96 sequential drawings of a hand (48 left and 48 right) are shown to the participants on the computer screen in 4 different views (back, palm, ulnar, radial) and 12 different rotation angles.

Participants are asked to assess whether the hand is right hand or left hand as quickly and accurately as possible. During this time, the participants are asked not to move and not to look at their own hands. They stand on their laps with their hands palms facing down. Response time measured in milliseconds.

Component 2: Finger-thumb position accuracy. Participants perform sequential finger-thumb opposition movements with aural tempo (1 Hz) in a fixed order, always starting with the second finger and ending with the fifth finger.

Component 3: Finger-thumb positioning speed. Participants perform an auditory-paced finger-thumb position sequence (same as described in component 2) whose speed is gradually increased (initial rate 40 beats/min, increasing by 10 beats/min every 5 seconds). Participants indicate that they cannot perform the task physically or mentally by saying "stop" on the microphone, and this time point is recorded as the "breaking point". Similar to Component 1, the response time is recorded (39,40).

1.3.12. Lateralization

Left/right discrimination requires a guess as to whether a depicted body part belongs to the body or is moving left or right. Three steps are assumed to be involved in the process: choosing left or right unconsciously, cognitively aligning the selected side for comparison, and then accepting or rejecting the initial selection (41). The validity of this procedure for neck and trunk movements has not been determined.

Response time and accuracy are the task's outcomes. It is frequently used to evaluate motor imagery because the task is carried out without moving the body portion being assessed (42–44).

1.3.13. The Recognise™

It is a software program created in 2012 by the Neuro Orthopedics Institute and Noigroup Publications. It provides a quick and easy assessment of lateralization. People are shown on the screen left or right foot, hand, shoulder, knee or torso, neck rotated or bent to the left or right. The total number of images presented can be set by the researcher as 6, 10, 20, 30, 40, or 50. Images are presented in random orientations (0°, 90°, 180°, 270°). At the end of the application, total accuracy and average reaction time are calculated. The mobile version of the Recognize™ hand, back, and foot lateralization (right-left discrimination) tasks is valid and reliable. Can be used in research and clinical practice in adult populations (45).

1.4. Chronometric Tests

1.4.1. Mental Chronometry

Another method used to assess visualization ability is mental chronometry. This tactic is based on comparing the time taken to complete motor activities when they are done and mentally mimicked. It is, in a sense, a comparison of movement times for actual and imagined motor tasks (46).

Knowing how long the physical action takes, the evaluator may ask the patient to indicate the beginning and end of the imagery performance. The mental stopwatch has some important limitations. It does not give information about MI vitality, but only about timekeeping properties. In addition, the timing of mentally simulated actions is not thought to represent actual movement times (26,47–49). Guillot and Collet explained that in sports activities, the similarity between the duration of real and imagined movements is valid only for automatic movements such as cycling or walking (50).

2. Conclusion and Recommendations

Imagination is a complex phenomenon in which vitality, intensity, and representation are not the same in every human being (51). The fact that imagery differs from person to person complicates the research processes in this field. Patients with impaired MI abilities could not benefit from MI training as much as patients with good MI abilities (52). Therefore, it is important to evaluate imagery ability before performing a visualization experiment or participating in imagery training.

As it is challenging to create test items that objectively assess the capacity to picture physical movements, subjective measures of visual vividness, such as MIQ and VMIQ, are frequently employed to examine MI ability. These evaluation techniques do, however, have some drawbacks. For instance, the movements that test subjects must imagine take a lot of time and complexity. Therefore, applying such tests makes it inconvenient in terms of time. In addition, there are conflicting results regarding the validation of these MI measurements. For example, in the original version of the VMIQ, participants are asked to rate a particular movement from both a first- and third-person perspective, either by "watching someone else" (claiming to measure the visual display of movements) or "doing it yourself" (claiming to measure kinesthetics). The problem with this instructible is that it gets confused with image perspective. Specifically, it does not specify whether the person performing the action should view himself/herself from a third-person perspective (i.e., watching himself/herself on television) or from a first-person perspective (i.e., as if he were doing the action himself/herself). Although Isaac et al. (1986) stated that the questionnaire was designed to assess both the visual and kinaesthetic aspects of motion imagination, but the instructions for the questionnaire do not mention kinaesthetic senses (33). MIQ is better than VMIQ at measuring motor images

(53). It assesses external imagery ability using subjective methods, questionnaires, interviews, or other self-report methods. Suica et al., in their review investigating the quality of MI ability assessment methods used in medicine, sports, psychology and education, concluded that MIQ, MIQ-R, MIQ-3 and VMIQ-2 are the best measures with adequate psychometric properties (54). Objective methods, on the other hand, measure imagery more internally, using behavioral, physiological, or neuronal measurements.

When the links between voluntary movement and MI were investigated, they were found to exhibit similar temporal patterns. The duration of mentally simulated actions should ideally match the time it takes to perform the same movements. Techniques like mental chronometry, which measures the temporal congruence between image and real time, are effective and flexible techniques for evaluating MI abilities. Nevertheless, despite the fact that chronometric methods are simple to use and affordable, the interpretative ability is not always easy to determine since aspects like motivation and anxiousness must be taken into account before making judgments regarding visualization ability (55).

3. Contribution to the Field

The effectiveness of motor imagery has been demonstrated in many different patient groups. The most efficient use of the motor imagery application, which has been widely used in the physiotherapy clinic, will be possible by evaluating the motor imagery ability. Choosing the appropriate assessment method will both increase the reliability of the assessment and provide a clearer demonstration of the effects of therapy.

Çıkar Çatışması

Bu makalede herhangi bir nakdî/ayni yardım alınmamıştır. Herhangi bir kişi ve/veya kurum ile ilgili çıkar çatışması yoktur.

Yazarlık Katkısı

Fikir/Kavram: MGK, NG; **Tasarım:** MGK, NG; **Denetleme:** MGK, NG, YAA; **Kaynak ve Fon Sağlama:** -; **Malzemeler: -; Veri Toplama ve/veya İşleme:** -; **Analiz/Yorum:-; Literatür Taraması:** MGK, NG, YAA; **Makale Yazımı:** MGK, NG; **Eleştirel İnceleme:** MGK, NG, YAA.

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