Systematic review of Spanish outcome measures on motor imagery ability: use in physical rehabilitation

Malena Melogno-Klinkas, Susana Núñez-Nagy, Silvia Ubillos-Landa

Introduction. Motor imagery is a mental representation of movement without any body movement and its training accelerates motor learning and improves motor skills. A thorough understanding of how to manipulate mental images is necessary before using motor imagery in physical rehabilitation. This systematic review analyzes the psychometric properties of the outcome measures on motor imagery ability for the Spanish-speaking people and discusses its usefulness in people with motor disabilities.

Materials and methods. A review was conducted, using the COSMIN checklist to appraise 19 articles on measurement properties of motor imagery ability assessments found in reviewed databases. The criteria for grading the usefulness of instruments to measure motor imagery was established depending on the sensory modality assessed. We found 17 questionnaires.

Results. Methodological quality was mostly fair in reliability and validity. Four tests have been considered highly useful in assessing motor imagery. MIQ (α = 0.90; EFA=2) and MIQ-R (α = 0.84; EFA=2) are the best suited to evaluate motor imagery in Spanish-speaking population. To handle spatial images, MASMI (α = 0.93) or MARMI (α = 0.90) tests may be more beneficial.

Conclusions. MIQ and MIQ-R evaluate visual and kinesthetic imagery, but these are difficult to use in the physical rehabilitation of people with motor disabilities. Currently, there are no valid Spanish translations of studies regarding motor imagery outcome measures for people with disabilities.

Key words. Assessment. Disability. Imagery. Mental practice. Motor skill. Questionnaire. Rehabilitation.

Área de Psicología Evolutiva y Educación (M. Melogno-Klinkas); Área de Psicología Social (S. Ubillos-Landa); Departamento de Ciencias de la Salud; Universidad de Burgos; Burgos. Departamento de Enfermería y Fisioterapia; Facultad de Medicina y Ciencias de la Salud; Universidad de Alcalá; Alcalá de Henares, Madrid, Spain (S. Núñez-Nagy).

Corresponding author:
Susana Núñez-Nagy, PhD. Departamento de Enfermería y Fisioterapia. Facultad de Medicina y Ciencias de la Salud. Universidad de Alcalá. Ctra. Madrid-Barcelona, km 33,600. E-28871 Alcalá de Henares, Madrid, Spain.

E-mail:
susana.nunez@uah.es

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Introduction

Motor disability represents a major public health concern. Mobility and activities of daily living are the most common components affected in disability. In 2011, there were an estimated 37.9 million people, living with a motor disability in the world [1].

In sports psychology, there is evidence that motor imagery (MI) training can accelerate learning and improve motor skills because MI and motor execution share some anatomical substrates and neurological networks [2]. More than physical practice alone, a combination of MI and physical practice is the most efficient condition for acquiring a motor skill [3]. For this reason, its use in neurorehabilitation has gained much attention as a promising tool that improves motor control and motor learning in people with motor disabilities. Imagery refers to the cognitive process that allows the manipulation of information generated in the mind in order to create a representation that is perceived through the senses [4]. Imagery can be visual, tactile, auditory, olfactory, and kinesthetic. In particular, MI may be defined as a dynamic state during which the representation of a given motor act is internally rehearsed within working memory without any overt motor output [5], this is a mental representation of movement without anybody movement. MI training is a mental practice program that consists of the mental representations of movements in order to learn or enhance their motor execution [6].

MI training has shown encouraging results in stroke victims [6]. Vividness of mental images of movements in stroke patients continues to be similar to age-matched controls, and stroke patients tend to display better imagery scores when they imagine movements with the unaffected side [7]. The efficacy of MI is shown in motor learning [6] except for right parietal lobe injury with implications in working memory [8].

MI vividness of patients with multiple sclerosis is similar to healthy controls but differs in imagery accuracy and chronometry. Although it is proven that visual or auditory external cues can improve the quality of MI [9].

The movements in Parkinson's disease are slow as it occurs during MI, but providing visual cues may enhance MI performance by reducing bradykinesia and increasing the vividness of movement images [10].

In a study of patients with subacromial impingement stage II in the field of trauma rehabilitation, it was concluded that MI seems to relieve pain, improve mobility, and may contribute to postponed surgery or even protect against the next stage of the disease [11].

Due to clinical relevance of MI training, it is important to assess MI ability. It is possible to evaluate different MI domains, which are exposed below.

MI characteristics

It is possible to imagine through different sensorial modalities. However, the visual and the kinesthetic aspects are the most important for rehabilitation purposes [3].

Different visual images may be employed depending on the sensory modality used in MI, such as displaying a film or the use of kinesthetic images, in which the subject feels like he is actually performing the movement. From the image perspective, one can imagine himself performing an action, called first-person or internal perspective, or a third person doing it, referred to as third-person or external perspective [2]. Visual images can be evoked by both. Kinesthetic images can only take place in internal perspective, when the imaginer feels as if he is performing the action.

Assessment

To benefit from MI, one must be able to engage in MI. Although this ability can be improved, it is very important to measure the ability of individuals to form mental images. This ability has heterogeneous issues that differ between individuals. It is a complex cognitive operation that makes the measurement of its ability a difficult task. Hence, it seems best to assess several domains of MI as vividness, accuracy and temporal coupling with at least two tools in MI [2,3], in order to gain a better insight of the ability to engage in MI.

There are five ways to assess the ability of MI:

- *Self-report questionnaires* to assess the vividness of mental images [12]. The subject is requested to rate how vivid a mental image is on a point scale. In most of cases, it is the subject himself who completes them. Self-report tests are economical, easy, valid, and reliable tools to assess mental image ability and the only way to assess vividness.
- *Temporospatial problem solving tests through mental manipulation*. Spatial tests and mental chronometry, which is the temporal congruence between imagery and the real time for performing it, measure the accuracy of mental images [3]. This type of test is not always possible to use in people with stroke, because temporal coupling may be affected in the injured area [12,13].
- *Functional neuroimaging techniques* register changes in metabolic brain activity, such as positron emission tomography (PET), functional magnetic resonance imaging (fMRI), or single photon emission computed tomography (SPECT). These methods must be performed simultaneously with an imagery task [14]. Obviously, testing with this type of technology is very expensive.
- *Qualitative procedures* are retrospective reports provided after performing an imagery experience. Due to their subjectivity, these procedures are complementary to the previous methods [3].
- *Neurophysiologic measurements* include the alert level through electrodermal conductivity or heart rate [3]. These are easier to use than neuroimaging techniques, but they also require training due to the variability of the autonomous nervous system responses between individuals. They must be used during the imagery experience.

MI questionnaires in English

The first self-report questionnaires developed to measure MI ability were the Vividness of Movement Imagery Questionnaire (VMIQ) [15] and the Movement Imagery Questionnaire (MIQ) [16]. Prior to these, the assessment was forced to rely on general vividness questionnaires or questionnaires relating to visual imagery only [17], so there are many tests to assess general mental imagery for English speakers as the Bett's questionnaire [18], Gordon [19], or the Vividness of Visual Imagery Questionnaire (VVIQ) [20].

Currently, there are four MIQ versions: MIQ, MIQ-R [21], MIQ-3 [22]and MIQ-RS [23]. The first three are only validated in healthy subjects and mainly used in healthy adults and athletes, because include items that are too physically demanding for persons with disabilities [7,17]. The MIQ-RS is easier to perform and can be used in people with disabilities; it is validated in English and French with stroke and healthy subjects [24,25]. Also inspired by MIQ-R, is the Kinesthetic and Visual Imagery Questionnaire (KVIQ) [26] which is validated to English, French, German and Chinese in stroke, Parkinson disease, multiple sclerosis and amputees [26-29]. It is still unknown which of these questionnaires have been validated into Spanish or designed in this language.

Aims

Self-report tests provide information that cannot be collected by other methods, such as the preferred sensory modality of the person or the vividness of mental images.

Because imagery can be evoked in different sensory modalities, mental images are not exclusively MI. However, MI evaluation appears to be closely linked to mental imagery of any kind in scientific literature. This paper presents an overview of the instruments that evaluate mental imagery ability for the Spanish-speaking population.

The aims of this systematic review are: to analyze the outcome measures on mental imagery ability for the Spanish-speaking population; to describe its psychometrical measurement properties; to discuss the method best suited for people with disabilities; and to conclude if it would be relevant to translate into Spanish any other MI ability outcome measures designed for people with motor disabilities.

Materials and methods

Search strategy

This review was performed using the databases PubMed, Web of Science, ScienceDirect, Scopus, Wiley Online Library, Scientific Research, PEDro, Ammons Scientific, CSIC; SciELO, MEDES, and Dialnet. The reference lists of the relevant studies were also carefully reviewed to identify additional studies for inclusion. It was conducted between May and July 2016 by two independent reviewers. The main results were collected in a previously defined form. Subsequent pooling was performed, and in the case of disagreement, the senior researcher involved in this review was requested to assist in reaching an agreement.

The subsequent search criteria were used, and only the most relevant were developed. On the PubMed database, six simple and two advanced searches were conducted. The keyword combination 'Spanish AND imagery' limited to the title and abstract yielded the best search results. On Web of Science database, one advanced search was performed. The keyword combinations were: 'Imagery ability AND questionnaire* OR test* OR assess* AND Spanish*', limited to topic. On Dialnet, a Spanish database, four searches were conducted: '*imagen del movimiento* AND *cuestionario*' '*imágenes mentales test*,' '*imágenes mentales*,' '*imaginación motora*,' '*imaginación cinestésica*,' '*imaginación visual*' and '*imaginería motora*' limited to journals and thesis.

Study selection criteria

Article selection was made following inclusion and exclusion criteria. The inclusion criteria were:

- Translation and validation imagery assessments for Spanish-speaking population.
- Measurement properties of Spanish outcome measures on imagery ability.
- Review articles about outcome measures on imagery ability for Spanish-speaking population.

The exclusion criteria were:

- Articles not related to mental practice or MI.
- Mental practice or MI studies that did not use Spanish outcome measures on imagery ability.
- Experimental studies that did not analyze measurement properties of the questionnaires even if the article used outcome measures on imagery ability for Spanish-speaking population.

Data extraction and quality appraisal

A three-stage approach to appraise the quality of the included instruments was conducted. First, the length of questionnaire, construct measured, and response format were extracted for each outcome measure (Tables I and II). Table III presents information about measurement properties of the studies included in the review.

Second, two reviewers independently assessed psychometric measurement properties using the COSMIN 4-point scale checklist [30]. Disagreements were resolved by a subsequent discussion. The COSMIN checklist is an accurate instrument recommended for use in systematic reviews of measurement properties, in which individual items within each domain are scored using a 4-point ordinal rating scale: excellent, good, fair and poor [30]. The COSMIN 4-point scale checklist [30] is

Table I. Outcome measures on mental imagery validated into Spanish.

	Construct	Format	Utility in MI
VES	Vividness visual imagery	15 items, 5 domains, dichotomous response. High score: high imagery	Medium. Only assess visual MI
VMIQ	Vividness visual imagery	24 items, 1 domain, rated on a 5-point scale. High score: low imagery	Medium. Only assess visual MI
MIQ	Vividness visual and kinesthetic imagery	18 items, 9 movements, 2 domains, rated on a 7-point scale. High score: low MI ability	High. Complex movements
VHMIQ	MI tactile sensations	Equal to VMIQ, different instructions	Medium. Only assess tactile imagery
VVIQ	Vividness visual imagery	16 items, 4 domains, rated on a 7-point scale. Fill out 2 times: opened and closed eyes. High score: low imagery	Medium. Only assess visual MI
VVQ	Cognitive style of mental imagery	15 items, dichotomous response. High score: visual style	Low. It is not subject of interest
Gordon	Controllability of visual imagery	12 items, rated on a 3-point scale (yes, no, unsure). Score 0-24. High score: High controllability	Medium. Only assess visual MI
Bett's	Mental imagery in any sensorial modality	35 items. 7 domains, rated on a 7-point scale. High score: low imagery capacity	Low. Unspecific
VVIQ-RV	Vividness visual imagery	32 items. 8 domains, rated on a 7-point scale. Opened or closed eyes. High score: high imagery ability	Medium. Only assess visual MI
MIQ-R	Vividness visual and kinesthetic imagery	8 items, 4 movements, 2 domains, rated on a 7-point scale. High score: high MI ability	High. Complex movements
OSIVQ	Cognitive style of mental imagery	45 items, 3 domains, rated on a 5-point scale. Higher score: cognitive style	Low. It is not subject of interest
VVIQ-2	Vividness visual imagery	32 items. 8 domains, rated on a 5-point scale. Fill out 2 times: opened and closed eyes. High score: high imagery	Medium. Only assess visual MI
CAIS	Auditory imagery clarity	7 items, rated on a 4-point scale. High punctuation: low clarity	Low. It measures auditory imagery
SIQ	Cognitive and motivational content of MI	30 items, 5 domains, rated on a 7-point scale. High punctuation: high MI in sports	Low. Professional sport

VES: Visual Elaboration Scale; VMIQ: Vividness of Movement Imagery Questionnaire; MIQ: Movement Imagery Questionnaire; VHMIQ: Vividness of Haptic Movement Imagery Questionnaire; VVIQ: Vividness of Visual Imagery Questionnaire; VVIQ-RV: Vividness of Visual Imagery Questionnaire-Revised Version; VVQ: Verbalizer-Visualizer Questionnaire; OSIVQ: Object-Spatial Imagery and Verbal Questionnaire; MIQ-R: Movement Imagery Questionnaire-Revised; CAIS: Clarity of Auditory Imagery Scale; SIQ: Sport Imagery Questionnaire.

divided into sections according to psychometric properties. An included description of how missing values have been handled is considered very important, and it is not possible to get a score higher than 'fair' if this is not mentioned. Each section contains questions about sample size and statistical methods. The section score corresponds to the lower value. For example, in the internal consistency section, a size greater than 100 subjects and calculating for Cronbach's alpha statistic for continuous variables is considered 'excellent'. Not analyzing the internal consistency for each subscale separately is scored as 'poor', so even if the other items have obtained an 'excellent' value, the total score for this section will be 'poor' if internal consistency has not been analyzed independently for each factor.

Finally, a criterion to determine overall utility in MI (high, medium or low) was established. Although imagery is multimodal, the most important aspects of MI for rehabilitation purposes are visual and kinesthetic [3]. So, if the instrument evaluates visual and kinesthetic MI, or it is a temporospatial solving problem test, utility was considered 'high'. If the instrument evaluates only the visual or kinesthetic sensory modality, the utility was considered 'medium'. If the instrument assesses another sensory modality or other issues of mental images, utility was considered 'low'.

Results

The search limits yielded 432 references where duplicates had been excluded. After a first screening on the titles and abstracts, 36 studies were identified as potentially eligible. The full texts of papers were retrieved for further evaluation, and 19 of these met the inclusion criteria. Preliminary studies to the main publication (*n* = 1) have not been taken into account (Fig. 1).

We found 17 assessments on imagery ability. Thirteen of these questionnaires had been translated and validated into Spanish [31-43], along with one version of precedents [44] (Table I), and three others were created in Spanish [45-47] (Table II).

Quality appraisal

The studies included performed analysis of internal consistency (89.5%), structural validity (63.2%), and criterion validity (63.2%), which was concurrent in all cases. None of them made another reliability analysis, checked measurement errors, content validity, or cross-cultural validity, or responsiveness (Table III). 89.5% of the studies were based on classical test theory models, and the remaining 10.5% on item response theory models, probably because some of the studies dated from 1988 (Fig. 2). Better scores were achieved by those who applied item response theory, although none of them had concurrent validity analysis.

According to the COSMIN checklist [30] for supporting reliable conclusions, a sample size of 100 is considered as 'excellent' and less than 30 as 'poor'. In this systematic review, all the studies analyzed met the criterion of including a sample size over 100 (Table III). Sample sizes ranged between 110 and 969 subjects. For factor analysis, larger sample sizes are required; it should be at least five to seven times the number of items with a minimum of 100. All but two of the studies that made factor analysis met this criterion [32,42].

Figure 1. Flow diagram of the search strategy.

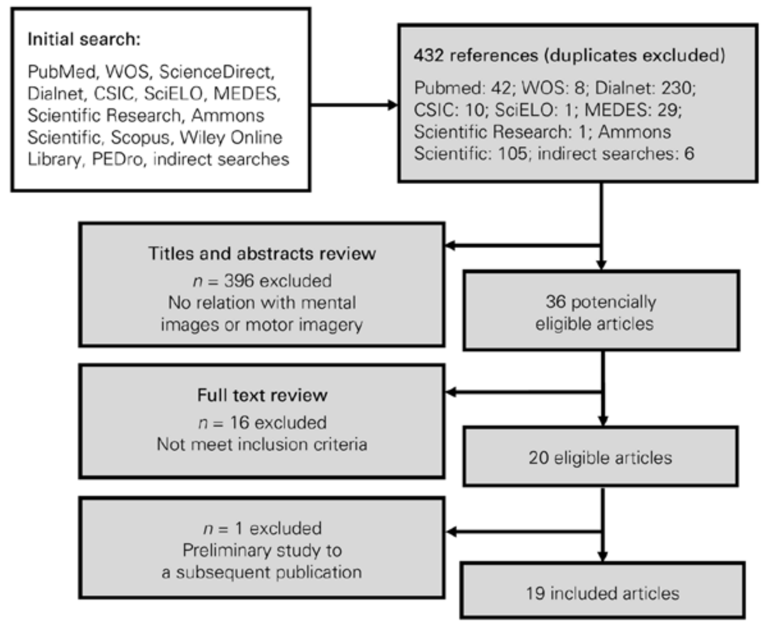


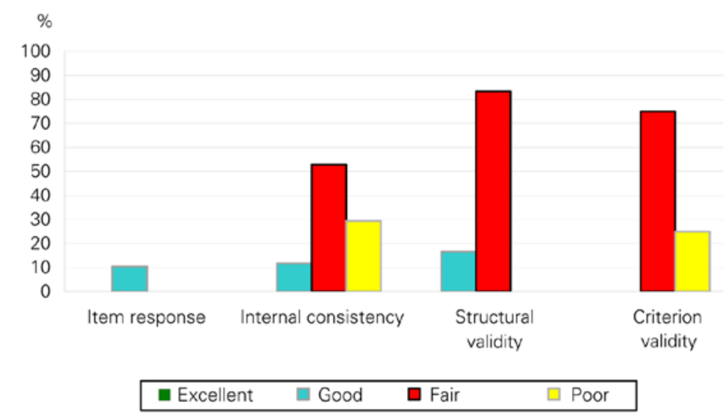
Table II. Outcome measures on mental imagery designed in Spanish.

	Construct	Format	Utility in MI
VVIT	Vividness visual imagery	21 items, dichotomous response. High punctuation: high imagery ability	Medium. Only assess visual imagery
MASMI	Ability to form spatial imagery	23 items, 10 min, multiple response, 2 false, 2 correct. Score: – 46 to 46	High. Use with self-reports tests
MARMI	Ability to rotate mental images	23 items, 10 min, multiple response, 2 false, 2 correct. Score: – 46 to 46	High. Use with self-reports tests

VVIT: Vividness of Visual Imagery Test; MASMI: Measure of the Ability to Form Spatial Mental Imagery; MARMI: Measure of the Ability to Rotate Mental Images.

The methodological quality was mostly fair for all measurement properties (Fig. 2). Three defects decreased the score. First, it was unclear how missing values were handled. If these data were known, all studies could have been classified better. The second most common error in the case of multidimensional tools was the absence of Cronbach's alpha for each factor, when internal consistency was analyzed (29.4%). Third, none of studies that analyzed criterion validity provided sensitivity and specificity data when the response was dichotomous.

Figure 2. Methodological quality according to COSMIN. The *x*-axis represents sections in the COSMIN checklist. The *y*-axis shows the percentage of studies that have achieved the scores.



High utility in MI: visual and kinesthetic imagery assessment or temporospatial test

Four tests have been considered high MI utility. Two assessments translated and validated into Spanish were identified to measure the ability to engage in visual and kinesthetic MI: Movement Imagery Questionnaire (MIQ) [33], and its revised version (MIQ-R) [40]. The MIQ [33] involves complex movements, such as the front roll. It was shortened and simplified in 1997, resulting in MIQ-R, which reversed the rating scale (Table I). Two factors were identified in both scales (Table III).

As noted, imagery ability can be measured with self-report questionnaires or with spatial tests. The Measure of the Ability to Form Spatial Mental Imagery (MASMI) [46,48] and the Measure of the Ability to Rotate Mental Images (MARMI) [47] are spatial tests designed for Spanish-speaking people. MASMI measures the ability to generate spatial images, and MARMI measures the ability to rotate mental images. Both consist of an unfolded cube that a subject has to mentally reassemble and answer some questions (Table II).

Medium utility in MI: visual or kinesthetic vividness assessment

Eight questionnaires have been considered of medium usefulness in MI because they only assess visual or kinesthetic aspects of imagery. The first mental imagery test used in Spanish-speaking populations was the Visual Elaboration Scale (VES) [31], which measures visual imagery in external perspective. Subjects are requested to imagine 4 different scenes and asked about details. Five factors were obtained (Tables I and III). Other questionnaires that have been translated into Spanish and assess individual differences of visual or tactile images are: Vividness of Visual Imagery Questionnaire (VVIQ) [34] and its two revised versions, (VVIQ-2 [39] and VVIQ-RV) [38], Gordon Test of Visual Imagery Control [36], Vividness of Movement Imagery Questionnaire (VMIQ) [32], Vividness of Haptic Movement Imagery Questionnaire (VHMIQ) [44], and Vividness of Visual Imagery Test (VVIT) [45] that measures visual imagery vividness and was created in Spain.

The VVIQ [34] and its two revised versions have one factor (Table III). VVIQ-RV [38,49] adds 16 items to the original one (Table I). It presents few items that measure high levels in the construct (difficulty items higher than 0.66). VVIQ-2 [39] has the same items as the revised version, but it does not revert the rating scale (Table I).

The VMIQ was created for assessing visual and kinesthetic imagery vividness. However, according to the psychometric analyses, it presents one factor [32] (Table III), which measures visual but not kinesthetic imagery. This may be due to its basis in the VVIQ [34]. From the VMIQ [32] a Spanish version was developed in order to appraise the tactile vividness of the movements called VHMIQ [44]. There is no evidence about its factorial structure (Table III). The subject must imagine himself doing the movement, so the evaluation applies to first person perspective. The subject must try to recreate movement sensations like temperature, resistance, and effort. For example, in swimming, he or she must imagine the feeling of water sliding on the skin, water resistance, fatigue, etc. (Table I). It is included under 'medium utility in MI' because it describes movement characteristics.

The Gordon Test was designed in 1949 by Rosemary Gordon. It measures controllability of external visual images. The subject is asked to visualize an object and after to change the color, environment, and movement. Four factors were identified [36] (Tables I and III). The Richardson's version of 1969 was used for its translation into Spanish [36].

In the VVIT [45], the subject is asked to imagine a particular object and is given a choice between a right and a wrong description (Table II). This test has six factors (Table III).

Low utility in MI: other issues or sensory modalities

Five questionnaires have been considered low utility in MI because they assess other sensory modalities.

Table III. Studies included in the review. Measurement properties.

	Sample	Internal consistency (Cronbach's α)	Structural validity	Concurrent validity
VES	*n* = 147 students (60 men) Mean age: 19.8 (18-23)	–	–	IDQ (*r* = 0,27 [a])
VES and VMIQ	*n* = 133 students (51 men) *n* =147 students (60 men) Mean age: 19.8 (19-23)	–	VES: EFA = 5 VMIQ; EFA = 1	–
MIQ	*n* = 110 students (63 men) Mean age: 20.1 (14-31)	0.90; 0.89 (visual); 0.88 (kinesthetic)	EFA = 2; 47.8% variance (visual: 35.2%; kinesthetic: 12.6%)	–
VVIT	*n* = 351 students (92 men) Mean age: 20.2 (19-25)	0.58	EFA = 6 (not well defined)	PMA (*r* = 0.42 [a]); Bett's (*r* = 0.48 [a]); VVIQ (*r* = –0.17 [a])
VHMIQ	*n* = 338 students (51 men) Mean age: 20.9 (18-26)	0.90	–	VMIQ (*r* = 0.60 [c])
VVIQ	*n* = 850 students (428 men) Mean age: 13.3 (12-16)	0.88	EFA = 1	–
VVQ	*n* = 969 students (496 men) Mean age: 14.2 ± 0.97	0.30	EFA = 5	Gordon (*r* = 0.08 [a])
Gordon	*n* = 479 students (70 men) Mean age: 20.5 (19-23)	0.69	EFA = 4; 55% varianza	VVIQ (*r* = –0.40 [c])
Betts	*n* = 562 students (148 men) Mean age: 20.2 ± 1.9	0.92	Spanish version: EFA = 8; 58,4% variance English version: EFA = 7	Gordon (*r* = 0.34 [b]); VVIQ (*r* = 0.58 [b])
VVIQ-RV	*n* = 414 students (96 men) Mean age: 20.5 ± 3.4	0.94	EFA = 1	–
VVIQ, VVIQ-2	*n* = 279 students (117 men) Mean age: 20.1 ± 1.9	0.91 (VVIQ); 0.94 (VVIQ-2)	Previous study EFA = 1	VVIQ, VVIQ-2 (*r* = 0.55 [a])
MASMI	*n* = 138 students (63 men) Mean age: 20.1 ± 1.8	0.93	–	PMA (*r* = 0.44 [b])
MIQ-R	*n* = 201 students (56 men) Mean age: 21.6 ± 1.8	0.84; 0.80 (visual); 0.84 (kinesthetic)	EFA = 2; 66.1% variance	VMIQ (*r* = –0.34 [c]); VVIQ (*r* = –0.26 [c])
OSIVQ	n = 213 students (62 men) Mean age: 19.6 ± 1.7	0.72; 0.77; 0.81	EFA = 3; 33.1% variance	–
VVIQ-RV, VVIQ-2	*n* = 206 students (43 men) Mean age: 19.7 ± 2.8	0.96 (VVIQ-RV); 0.91 (VVIQ-2)	Previous study EFA = 1	VVIQ-RV, VVIQ-2 (*r* = 0.67 [b]); Betts (*r* = 0.53 [b])
CAIS	*n* = 234 students (47 men) Mean age: 19.6 ± 1.5	0.82	EFA = 5; 57.4% variance	VVIQ-2 (*r* = 0.42 [a]); Betts (*r* = –0.25 to –0.42 [b])
MARMI	*n* = 354 students (45 men) Mean age: 19.5 ± 1.9	0.90	–	PMA (*r* = 0.38 [b]); MASMI (*r* = 0.48 [b])
MASMI	*n* = 254 students (108 men) Mean age: 19.4 ± 1.8	0.93	–	–
SIQ	*n* = 361 athletes (234 men) Mean age: 24.1 ± 7.2	0.72-0.86	EFA = 5; CAF (5 factors). $\chi^2_{(378)}$ = 694.6; CFI = 0.91; TLI = 0.90; RMSEA = 0.05; SRMR = 0.05	–

EFA: exploratory factor analysis; VES: Visual Elaboration Scale; IDQ: Individual Differences Questionnaire; VMIQ: Vividness of Movement Imagery Questionnaire; MIQ: Movement Imagery Questionnaire; VVIT: Vividness of Visual Imagery Test; PMA: Primary Mental Abilities; VHMIQ: Vividness of Haptic Movement Imagery Questionnaire; VVIQ: Vividness of Visual Imagery Questionnaire; VVIQ-RV: Vividness of Visual Imagery Questionnaire-Revised Version; VVIQ-2: Vividness of Visual Imagery Questionnaire-2; VVQ: Verbalizer-Visualizer Questionnaire; OSIVQ: Object-Spatial Imagery and Verbal Questionnaire; MASMI: Measure of the Ability to Form Spatial Mental Imagery; MIQ-R: Movement Imagery Questionnaire-Revised; CAIS: Clarity of Auditory Imagery Scale; MARMI: Measure of the Ability to Rotate Mental Images; SIQ: Sport Imagery Questionnaire. [a] $p < 0.05$; [b] $p < 0.01$; [c] $p < 0.001$.

The Sport Imagery Questionnaire (SIQ) has five factors and evaluates the contents of imagery in relation to cognitive and motivational issues of sports and competition [43]; therefore, it is used exclusively in professional sports (Tables I and III).

Less specific to MI is Bett's Questionnaire upon Mental Imagery because all sensory modalities are evaluated and not only movement. This test was the first developed by George Herbert Betts in 1909. The Sheenan's version of 1967 was used for its validation into Spanish [37]. The ability to engage in mental imagery is evaluated in seven sensory modalities (visual, auditory, olfactory, gustatory, cutaneous, kinesthetic and organic), which meets its factorial structure in the English version (EFA = 7) but not in the Spanish one (EFA = 8) (Table III).

The Verbalizer-Visualizer Questionnaire (VVQ) measures the cognitive style of mental images, and subjects are classified into visualizers or verbalizers. Its structural validity was analyzed, and it has five factors [35]. The OSIVQ [42] measures the same aspect, but subjects are classified into three categories: verbal, visual spatial, or visual object, which is confirmed by its factorial structure analysis (EFA = 3) (Tables I and III).

The Clarity of Auditory Imagery Scale (CAIS) [41] measures the vividness of auditory mental images and has five factors (Tables I and III).

Discussion

Most of the studies in this review have fair measurement properties. However, determining the most useful instruments is a trade-off between psychometric qualities and the instrument's feasibility or ease of use. For this reason, and taking into account the objective of this review, this discussion focuses mainly on the scales that are considered high utility in MI.

There are not questionnaires in Spanish validated to clinical populations. The role of assessment in clinical is extremely important. It is necessary to measure the ability to form mental images before using MI training in physical rehabilitation treatment. It was determined which tests translated into Spanish are useful in MI. However, none of them would be useful in physical rehabilitation with people with disabilities because movements requested to carry out before the mental practice activity, are very complex and demanding [7,17].

The MIQ and MIQ-R, which have fair measurement properties, are widely used in sports psychology [40]. MIQ-R and MIQ-3 are both short, easy and have widespread use [11] but MIQ-3 is not translated into Spanish yet. It is possible to use them in a physical rehabilitation treatment if the person does not have motor disabilities because complex movements, such as jumping or standing on one foot are possible. Some authors even consider that the MIQ-R should contain more instructions at the beginning because in the visual subscale when subjects are asked to form a mental image of the movement, it is not explained if they must use internal perspective or external perspective. The MIQ-RS has attempted to correct these difficulties. It removes problematical items, such as jumping, and includes easier movements. It shows adequate psychometric properties, and it seems an appropriate choice to examine the MI ability, especially in the upper limbs. It is validated for people with mild stroke [25], but it is not translated into Spanish. The KVIQ [26] can also be used in people with reduced mobility. It is translated into several languages, shows adequate measurement properties, and it is validated in clinical populations [26-29]. However, it is not yet available in Spanish.

SIQ has good psychometric properties, although it has not been classified as having high utility in MI because it does not evaluate the vividness of kinesthetic and visual images. However, the information provided about motivational and cognitive aspects in the context of competitive sports would be of interest to athletes attending physical rehabilitation in order to guide personalized training with mental practice.

There is evidence that the ability to rotate mental images shares neuronal processes with motor acts. As other authors have postulated, for measuring accuracy domain in MI it is necessary to use these spatial tests as well as the self-reported questionnaires [3,12]. Designed in Spanish, it is possible to use MASMI [46] or MARMI [47], which have fair properties. Although temporal coupling is impaired in stroke subjects with severe sensory loss, it has not impact on mental rotation abilities [50].

There are not specific questionnaires even in English or in Spanish to measure mental chronometry. Scientific literature recommends using another test and compare the time it takes to perform the movement and the time of mental practice [12,50, 51]. The most widely used tools are the Timed Get Up & Go [52] that is translated into Spanish and the Box and Block Test [53], whose instructions are only in English. Chronometry gets worse with age in healthy subjects [51] and tends to be underestimated in clinical populations, that is, patients who believe that they perform the activity more quickly than they really do, albeit there is no general agreement about this. This imbalance occurs in stroke with severe to moderate sensory loss [50], but in Parkinson disease there is no common agreement [54,55] and in multiple sclerosis there seems to be good temporal organization [9].

Despite not meeting the criteria to be considered highly useful in MI established in this review, the VHMIQ [44] allows a more accurate recreation of the environment. Some authors support the idea that the benefits of MI are higher when the environment is recreated or when MI is practiced in the same context in which actual practice is performed [3]. When athletes report their imagery experience (qualitative interviews), they describe strategies to improve their MI, such as picking up the sports implements or moving any part of the imagined body during MI practice, simulating the action. It might be interesting to assess the ability of these individuals to generate such images with this questionnaire, to evaluate whether MI is improved in an environment close to reality or if it is beneficial to perform a treatment with this sensory modality. However, it is more important in the beginning to understand the patient's ability to engage in MI in a physical rehabilitation treatment. Therefore, it may be used in combination with other MI instruments.

Study limitations

The low visibility of Hispanic publications is a limitation of this review. International databases contain few articles in Spanish, and it is difficult to refine the searches in Hispanic databases, which may be considered as publication and selection bias. Hand searching and queries to the authors have been carried out to minimize this limitation as much as possible.

The COSMIN checklist ratings are based strictly on information published in the articles; authors were not contacted to request details. Therefore, some elements that were rated as "unclear" may have been inequitable.

Also, it is a limitation for physical rehabilitation not to have instruments that evaluate MI ability for Spanish-speaking.

In conclusion, psychometric research supports the evidence-based decision making that is necessary for effective MI treatment.

There are no validated Spanish questionnaires for people with reduced mobility; therefore, it will be difficult to choose patients who will benefit from MI training in rehabilitation. It is necessary to translate and validate assessments that evaluate the vividness of MI for people with physical disabilities and have shown appropriate measurement properties in other languages.

The questionnaires best suited to evaluate MI ability for Spanish-speaking population are the MIQ and MIQ-R because they measure visual and kinesthetic imagery. However, although they have fair psychometric properties, it is difficult to use them in physical rehabilitation treatment if the person has motor disabilities, because of the complexity of the movements. It is needed an instrument that measures MI ability where the movements are easy to carry out, since they must be done before imagery. Only the MIQ-RS and the KVIQ in English meet these requirements but they are not validated into Spain yet.

To evaluate the spatial issues of MI, it is possible to use tests like MASMI and MARMI, which also have fair psychometric properties or measuring chronometry.

This systematic review shows the need to validate the MIQ-RS and the KVIQ into Spanish in clinical populations. Currently, this team research is validating the Spanish KVIQ in stroke population.

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Revisión sistemática sobre instrumentos de valoración de la imaginación motora para población hispanohablante: su uso en rehabilitación

Introducción. La imaginación motora es el acto de imaginar una acción sin realizar el movimiento físico. Su práctica acelera el aprendizaje y mejora las destrezas motrices. Previamente a la rehabilitación física utilizando la imaginación motora, es necesario evaluar la capacidad de los individuos para formar y manipular imágenes mentales. Esta revisión sistemática analiza las propiedades psicométricas de las herramientas existentes que miden la imaginación motora en la comunidad hispanohablante y discute su utilidad clínica en personas con discapacidad motora.

Materiales y métodos. Se hallaron 19 artículos en diferentes bases de datos, y se aplicó la escala COSMIN para evaluar los 17 instrumentos de medida hallados sobre imaginación mental. El criterio utilizado para graduar la utilidad clínica de estas herramientas fue establecido en función de la modalidad sensorial evaluada.

Resultados. La calidad metodológica de los estudios fue aceptable en términos de fiabilidad y validez. Cuatro cuestionarios se consideraron de utilidad alta en imaginación motora. El *Movement Imagery Questionnaire* (MIQ) (α = 0,90; AFE = 2) y su versión revisada (MIQ-R) (α = 0,84; AFE=2) son los cuestionarios autoadministrables que mejor se ajustan para evaluar la imaginación motora en la población hispanohablante. Entre los tests espaciales es posible utilizar la medida de la aptitud para formar imágenes mentales espaciales (α = 0,93) o la medida de la aptitud para rotar imágenes mentales (α = 0,90).

Conclusiones. Aunque el MIQ y el MIQ-R evalúan la imaginación visual y cinestésica, su aplicación en la rehabilitación con personas con discapacidad motora es complicada. Actualmente no hay instrumentos validados en castellano para población con discapacidad física.

Palabras clave. Cuestionario. Destreza motora. Discapacidad. Evaluación. Imágenes. Práctica mental. Rehabilitación.