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Original article

Motor creativity assessment: A test-retest reliability and validity protocol study in fibromyalgia and healthy women

Évaluation de la créativité motrice : une étude de protocole test-retest sur la fiabilité et la validité dans la fibromyalgie et les femmes en bonne santé

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A B S T R A C T

Introduction. – Previous studies have found brain abnormalities and deficits in cognitive functions in people with fibromyalgia. It is known that choreography or creative tasks significantly generate cognitive improvements. Various methods have been described in the literature to evaluate creative activities using electroencephalography (EEG), such as the imagination of dance improvisations. However, there is the notion that creative solutions can emerge during the action and that creative motor action may reflect new, statistically rare, and adaptive coordination and/or the control solutions performed.
Aim. – This study seeks to establish an operational approach to test how constraints are combined to induce variability of movement and how to evaluate it, but without forgetting the ideation or preparation of the activity as a relevant section in the study of motor creativity. To this end, this study aims to validate and test the reliability and applicability of an innovative test of motor creativity: The Motor Creativity Assessment (MCA), with the aim of achieving an objective score of motor creativity that can be used to test patients and monitor the interventions.
Material and methods. – to correctly satisfy the requirements of the standard protocol for clinical trials, this study has followed the SPIRIT 2013 Statement Items. A total of 13 women with fibromyalgia and 13 healthy women were included in the study. The individual's cognitive impairment, sleep quality, pain, quality of life, level of physical activity, fear of falling, and the impact of fibromyalgia will be studied. This study develops a specific test of motor creativity without the use of objects, with the aim of achieving an objective score of motor creativity. An observation score sheet allows motor creativity to be analyzed and scored by viewing a video of the creative movement test. The Enobio® instrument (Neuroelectrics, Cambridge, MA, USA) and Neuroelectrics® instrument driver software (NIC1) were used to record EEG and heart rate variability signals.

Mots clés :
Créativité motrice
Danse
Douleur
EEG
Évaluation de la créativité

R É S U M É

Introduction. – Des études ont révélé des anomalies cérébrales et des déficits des fonctions cognitives chez les personnes atteintes de fibromyalgie. On sait que la chorégraphie ou les tâches créatives génèrent de manière significative des améliorations cognitives. Diverses méthodes ont été décrites dans la littérature pour évaluer les activités créatives utilisant l'électroencéphalographie (EEG), comme la danse improvisée. Cependant, des solutions créatives peuvent émerger au cours de l'action et l'action motrice

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créative peut refléter une nouvelle coordination statistiquement rare et adaptative et/ou les solutions de contrôle mises en œuvre.

But. – Cette étude cherche à établir une approche opérationnelle pour tester comment les contraintes se combinent pour induire la variabilité du mouvement et comment l'évaluer, mais sans oublier l'idéation ou la préparation de l'activité comme section pertinente de l'étude de la créativité motrice. À cette fin, cette étude vise à valider et tester la fiabilité et l'applicabilité d'un test innovant de créativité motrice : évaluation de la créativité motrice (MCA), afin d'atteindre un score objectif de créativité motrice pour tester les patients et suivre les interventions.

Matériel et méthodes. – Cette étude a suivi les éléments de la déclaration SPIRIT 2013. Treize femmes atteintes de fibromyalgie et treize en bonne santé seront incluses dans l'étude. Les troubles cognitifs, la qualité du sommeil, la douleur, la qualité de vie, le niveau d'activité physique, la peur des chutes et l'impact de la fibromyalgie seront étudiés. Cette étude développe un test spécifique de créativité motrice sans utilisation d'objets, afin d'atteindre un score objectif de créativité motrice. Une fiche d'observation permet d'analyser et de noter la créativité motrice grâce à un visionnage vidéo du test de mouvement créatif. L'instrument Enobio® (Neuroelectrics, Cambridge, MA, États-Unis) et le logiciel de pilotage d'instrument Neuroelectrics® (NIC1) seront utilisés pour enregistrer les signaux EEG et de variabilité de la fréquence cardiaque.

1. Introduction

Fibromyalgia is characterized by widespread pain, fatigue, stiffness, reduced physical fitness, sleep disturbances, in particular, insomnia [63] and psychological symptoms, such as anxiety and depression [17]. These symptoms reduce the quality of life [6,39,59] and activities of daily living performance of fibromyalgia patients [18,26]. The prevalence of fibromyalgia in the general population is between 0.2 and 6.6% [38], mainly in women over 50 years old [47]. In addition, previous studies have found brain abnormalities in people with fibromyalgia, which could be associated with an accelerated brain aging [32]. These morphological and physiological differences might explain that people with fibromyalgia show deficits in cognitive functions, such as attention, executive function and verbal memory [29,63]. In addition, a decrease in gray matter volume in the hippocampus and prefrontal cortex has recently been studied in this population [34,43]. In this sense, according to the first brain-inspired neural network model of creative cognition, the prefrontal cortex plays a relevant role in creative ideation by providing a control mechanism. Additionally, thinking about novel solutions activates distant connected neurons in a semantic network that involves the hippocampus [31].

A recently published meta-analysis suggests creative dance-based interventions could be more effective than repetitive dance-based interventions to reduce pain and fibromyalgia impact [44]. This difference may be since tasks that involve creative and innovative choices or tasks are more challenging than simple imitation or closed reproduction of activities (without decision or creation) [16,37,49]. In addition, a study concluded that performing tasks without making relevant decisions such as guided exercises, aerobics, Zumba, or exercises combined with memory tasks do not significantly improve the cognitive effects more than simple motor tasks or motor exercises. However, choreography tasks or creative tasks, such as being the partner leading of a dance or learning and performing a choreography, significantly generated cognitive improvements [49]. Creative art therapy has been used to assist patients and families in increasing self-awareness, ameliorating symptom burden, and adapting to the stressful life experiences associated with an illness [27]. Specifically, motor creativity can play an important role in gradual adaptation to changes perceived scenarios, such as changes in pain during activities of daily living due to the evolution or seasonality of the disease, or changes in fitness due to training or detraining.

The relationship between motor creativity and cognition is an open topic and addressed in different ways. On the one hand, there is the idea that creative movements are creative ideas enacted. This hypothesis is consistent with cross-sectional associations between creative thinking and creative sports performance [54]. On the other hand, there is the idea that creative solutions can emerge during action [25] and that creative motor action may reflect new, statistically rare and adaptive coordination and/or the control solutions performed. Thus, the organization and reorganization of an individual's movement after systematic manipulation of conditions provides a way to test how and why creative motor actions arise [46]. In this sense, different studies have suggested that research focus on questions related to how to structure exploration and induce variability within the learning context to enhance creativity [25,46]. To do this, an individual can be invited to explore a workspace to generate greater variability of movements and generate adaptations. This greater variability of movement can generate the appearance of creative motor actions. We know that nonlinear tools expose the complexity inherent in variability, revealing characteristics of motor control that are important for therapists to measure and implement in an intervention. Thus, to measure a task, skill, or variable may show emergence of a new level of function. The application of principles based on nonlinear dynamics and the use of nonlinear tools for movement analysis can provide innovations to guide the practice and research of physical therapies [21,56,62]. For this reason, in this approach to the analysis and assessment of motor creativity, we cannot forget the theory of the variability in human movement as a characteristic of healthy functioning. It is known that healthy motor control has characteristics of nonlinearity, including the spontaneous generation of new patterns of movement, movement possibilities that are sensitive to initial conditions, and a limited ability to precisely predict future movement based on current status [21]. In addition, we understand that motor creativity can be influenced or related to different variables such as cognitive impairment [53], sleep quality [60], pain [8], quality of life [30], level of physical activity [57], fear of falls [19] or the impact of fibromyalgia [44]. Therefore, in this study we control these variables to study the relationship between motor creativity and the main symptoms of a known population.

This study seeks to establish an operational approach to test how constraints are combined to induce variability of movement and how to evaluate it, but without forgetting the ideation or preparation of the activity as a relevant section in the study of motor creativity. To this end, this study aims to validate and test the reliability and applicability of an innovative test of motor creativity: The Motor Creativity Assessment (MCA), with the aim of achieving an objective score of motor creativity to test patients and monitor the interventions and follow-ups. In the scientific literature we have found several motor creativity tests [2–4,15,20,40,55,58,65]. However, to the best of our knowledge, this is the first test without manipulation of objects and in which only tasks related to body movement have to be solved together with a previous imagination and planning task according to this first brain-inspired neural network model of creative cognition [31].

In turn, it is intended to compare the electrical brain activity of the different moments of the creative test and compare it with a repetitive task, differentiating in both cases the moment of ideation and the moment of execution. Various methods have been described in the literature to evaluate creative activities using electroencephalography (EEG), such as musical improvisation [37] or the imagination of an improvised dance [16]. Analyzing brain electrical activity during these creative cognitive processes, as well as during improvisation and the search for novel motor patterns, aims to increase knowledge by following and complementing the first brain-inspired neural network model of creative cognition, since most works the above provide mainly theoretical and conceptual models of creativity.

2. Methods

This study, to correctly fulfill the items of the standard protocol for clinical trials, has followed the SPIRIT 2013 Statement Items [10]. The study will be performed in accordance with the Declaration of Helsinki and all applicable laws and regulations of the countries in which the trial is conducted. Trial registration will be available at ClinicalTrials.gov. The study protocol is currently approved by the Research Ethics Committee of the University of Extremadura (approval number: 191/2022).

2.1. Participants

Our primary objective is to determine the level of agreement for the creativity score that assesses the level of satisfaction of the same respondents at two different periods (time 1 and time 2) by determining its test-retest reliability. Test-retest reliability is usually applied to determine the consistency level for validating a questionnaire design, especially during the initial pilot test. Since this test-retest reliability will only involve two observations, the minimum number of participants required will be 22, 15 and 10 for detecting the values of ICC of 0.5, 0.6 and 0.7, respectively [5]. Another outcome are the EEG power spectrums (theta, alpha and beta bands). In this regard, most studies analyzing the EEG power spectrum used topographic images to report the results. Therefore, quantitative data that can serve as input to sample size calculators are unavailable. In addition, no previous studies analyzed the EEG response to dance in adults with fibromyalgia. All these reasons together, make it impossible to perform an adequate sample size calculation based on previous studies in the field.

In this sense, a total of 26 women will participate in the study. The inclusion criteria will be set as follows: (a) female between 30–75 years of age; (b) be able to communicate with the research staff; (c) have read, understood, and signed the informed consent form. In addition, women with fibromyalgia must have been diagnosed by a rheumatologist, according to the American College of Rheumatology criteria [64]. The exclusion criteria will be: (a) psychiatric or neurological disorders; (b) pharmacological treatment for anxiety or depression; (c) substance abuse or dependence; (d) contraindication for physical effort; (e) difficulty maintaining balance and (f) being pregnant. Therefore, the sample will be collected in September 2023. One group will be composed of women with fibromyalgia ($n = 13$) from the AFIBROEX association, while the other group will be healthy women ($n = 13$).

2.2. Outcomes

Sociodemographic information such as age, level of education, injuries, or falls in the last few months, as well as other health-related information, will be asked. The International Physical Activity Questionnaire (IPAQ) will be used to assess physical activity and inactivity. It will be used to obtain total metabolic equivalents (METs) per week as well as time spent sitting [13]. The Spanish version of the IPAQ [13,50] will be used in this study. In addition, body composition will be measured with the Tanita BC-418 Body Composition Analyzer [48].

The Montreal Cognitive Assessment (MoCA) is a brief cognitive screening that assesses the following cognitive abilities: attention, concentration, executive functions (including abstraction), memory, language, visual-constructive skills, calculation, and orientation. It has high sensitivity and specificity for detecting mild cognitive impairment even in patients whose performance on the Mini-Mental State Examination (MMSE) is in the normal range [45]. It has also been more sensitive than MMSE in people with fibromyalgia [42]. In addition, 23/30 will be the cutoff point as it has been found to have better diagnostic accuracy, reducing the false positive rate [9]. The administration time required is about ten minutes. The maximum score is 30 [24]. The Spanish version of the MoCA will be administered in this study [14].

The Fibromyalgia Impact Questionnaire Revised (FIQ-R) [1] is a self-administered questionnaire consisting of 21 items. Each item is scored from 0 to 10, being 10 the worst condition. It is divided into three domains: (a) function, (b) overall impact, and (c) symptoms, and the maximum score is 100, corresponding to the worst overall symptom impact. The Spanish version of the FIQ-R [52] will be administered to people with fibromyalgia in this study.

The Falls Efficacy Scale International (FES-I) is a self-administered questionnaire that comprising 16 items that are scored on a four-point scale in which the higher the score, the greater the fear of falling [66]. This questionnaire has previously been used in people with fibromyalgia [36]. The Spanish version of the FES-I will be used in this study [35].

The EuroQol-5 dimensions-5 levels (EQ-5D-5L) is used to measure health-related quality of life (HRQoL) [22]. It consists of five dimensions (mobility, self-care, activities of daily living, pain or discomfort, and anxiety or depression) and five levels per dimension. EQ-5D-5L provides a time-preference based utility anchored from death (= 0) to full health-related quality of life (= 1) that could be used in to measure health status and health economics. The EQ-5D-5L also includes a visual analogue scale (VAS), which rates perceived health status from 0 (worst imaginable health) to 100 (best imaginable health).

The Pittsburgh Sleep Quality Index (PSQI) measures the sleep quality and sleep disturbances of the participants over one month on seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is evaluated from 0 to 3, and the total score ranges from 0 to 21 [7]. Higher scores indicate poorer subjective sleep quality. The Spanish version of the PSQI, validated for use in fibromyalgia patients, will be used [23].

2.3. Motor creativity assessment

Various methods have been described in the literature to evaluate creative activities using EEG, such as musical improvisation [37] or the imagination of improvised dance [16]. Following these methods, four scenarios will be presented with a performance interval of three minutes:

- imagine a model reproduction: the participants will be instructed to close their eyes and to imagine themselves dancing a choreography in a certain space shown previously on a screen (a monotonous standard dance);
- imagine an improvisation: participants will be asked to mentally perform a free improvised dance with their eyes closed. They will be asked to imagine themselves in a certain space and try to imagine original moves. Different objectives will be indicated to help the participants: (a) draw their name using different parts of the body; (b) explore different displacements and speeds and (c) modify the height and the parts of the body that rest on the floor. After, the participants will be interviewed about the imagined dance task. The questions will be about the imagined dance (for example, colors, description of movements, elements of the place, etc.) to verify that they were performing the task;
- reproduction of dance movements: participants will be asked to perform a monotonous and standard choreography following a teacher shown on the screen;
- perform an improvisation: Participants will be asked to perform a free improvised dance. They will be asked to perform original dance moves in a certain space. In addition, different objectives will be indicated to help the participants: (a) draw your name using different parts of the body; (b) explore different displacements and speeds and (c) modify the height and the parts of the body that rest on the ground.

2.4. Creativity score

This study aims to establish an operational approach to verify how the restrictions are combined to induce movement variability and how to evaluate it, but without forgetting the ideation or preparation of the activity as a relevant section in the study of motor creativity. To this end, this study aims to establish a specific test of motor creativity without the use of objects, with the aim of achieving an objective score of motor creativity. This observation sheet allows motor creativity to be analyzed and scored through a video viewing of the creative movement test (see Appendix 1).

The observation sheet has a first section that is not scored (1. Preparation task). This section confirms that the participant has correctly carried out the imagined preparation exercise. If the participant does not answer three or more questions, she must do the task again.

The second section (2. Motor Assessment Task) is divided into two scores. The first (A. Objectives Achieved) is based on fulfilling the items asked of the participant. These items have been developed considering movement factors [33]. Finally, we have the second score (B. Creative Features), based on the main measures into which creativity is divided: fluency, flexibility and originality. Fluency represents the number of movements performed. Flexibility represents the ability to modify a movement. Originality represents the ability to perform non-stereotyped and different movements in each context.

Dance and movement professionals have studied and developed the number of times that the person must perform each item or movement to be scored. For this, they have considered the time spent on the task, the difficulty and the type of response. This analysis is developed to ensure that the observation sheet is sensitive to real change and a reliable tool to measure motor creativity.

2.5. Electroencephalography (EEG) and heart rate variability (HRV)

The Enobio® instrument (Neuroelectrics, Cambridge, MA, USA) [51] and Neuroelectrics® instrument driver software (NIC1) were used to record EEG and HRV signals. The reliability of this device has been proven even when using "dry" electrodes [12]. Therefore, this device allows us to evaluate the EEG signal in 19 channels, according to the International System 10-20, in different brain areas: frontal (Fz, Fp1, Fp2, F3, F4, F7, and F8), central (Cz, C3, and C4), temporal (T3, T4, T5, and T6), parietal (Pz, P3, and P4), and occipital (O1 and O2). Two electrodes placed on the mastoids functioned as a reference. The impedance was kept below 10 KΩ during recording. In this regard, the sampling frequency is 500 Hz, with a 50 Hz notch filter and a bandpass filter from 1 to 40 Hz. In addition, to process data collected in DT, we used the recommendations given in the work of Cheron et al. [11] to perform EEG recordings in movement. In this respect, the ASR filter will be used [41].

The MatLab toolbox, EEGlab, will be used to pre-process and analyze the data. Artifacts with a non-cortical source (eye movements, muscle activity, or line noise) will be corrected by independent component analysis (ICA) [28]. Once all sources of artifacts will be corrected, using the pop_spectopo.m function of EEGlab, we will separate the signal into six different spectral power bands: theta (4–7 Hz), alpha-1 (8–10 Hz), alpha-2 (11–12 Hz), beta-1 (13–18 Hz), beta-2 (19–21 Hz), and beta-3 (22–30 Hz).

2.6. Procedure

First, an anthropometric measurement will be carried out to calculate the participants' body mass index (BMI). Next, participants will be required to answer sociodemographic questions and complete a set of questionnaires, including the International Physical Activity Questionnaire (IPAQ), Fibromyalgia Impact Questionnaire-Revised (FIQ-R), Falls Efficacy Scale International (FES-I), EuroQol 5 dimensions-5 levels (EQ-5D-5L), and the Pittsburgh Sleep Quality Questionnaire (PSQI).

After finishing the questionnaires, a 5-minute baseline EEG recording will be conducted. This will be followed by the administration of a cognitive test (MoCA) and then the Motor Creativity Assessment (MCA). The conditions during the MCA will be recorded with a video camera for later analysis by evaluators. Brain and cardiac electrical activity will also be recorded during the MCA using EEG and HRV. All measurements will take place at the University facilities, and the MCA will be repeated after seven days.

2.7. Statistical analysis

The outcome results will be included in an anonymous dataset to conduct the statistical analyses. Descriptive and quantitative analyses will be reported. The Statistical Package for the Social Sciences (SPSS, version 24.0; IBM Corp, Armonk, New York, NY, USA) will be employed. Descriptive statistics of age and anthropometric measurements will be calculated for the whole sample. Parametric or no parametric tests will be conducted based on the results of the Shapiro–Wilk test.

The applicability will be measured as the percentage of participants who adequately performed the CMA test. To test the concurrent validity, we will compare the creativity with the scores of the outcome variables, EEG and HRV signals. In addition, we will compare the creativity–non-creativity tasks scores of electrical brain activity.

Regarding reliability, recommendations by Weir [61] will be followed to measure the reliability of the creativity motor test. The selected intraclass correlation coefficient (ICC) will be 3.1 (two-way mixed, single measures). Absolute reliability will be determined by computing the standard error of measurement, calculated as $SEM = SD \times \sqrt{1 - ICC}$, where SEM is the standard error of measurement and SD is the mean SD of the two outcomes (test and retest). The smallest real difference will be calculated as $1.96 \times SEM \times \sqrt{2}$. Both the standard error and the smallest real difference (SRD) will be transformed into percentages to enable comparisons with future studies. The interrater and intrarater reliability will also be analyzed.

Ethics and dissemination – Institutional review board statement

The study protocol is currently approved by the Research Ethics Committee of the University of Extremadura (approval number: 191/2022). The participants will sign an informed consent form for the confidentiality of their data. The data of this research will be confidential and will only be analyzed by contracted research staff. The results of this study will be published in scientific journals that offer online access and will be also presented at national and international conferences.

Disclosure of interest

The authors declare that they have no competing interest.

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Institutional Review Board Statement

The study protocol is currently approved by the Research Ethics Committee of the University of Extremadura (approval number: 191/2022). The participants will sign an informed consent form for the confidentiality of their data. The data of this research will be confidential and will only be analyzed by the study staff not involved in the intervention.

Author contributions

Conceptualization, A.M.-G., P.M. and N.G.; data curation, M.C.G.-A.; formal analysis J.L.L.-L.; funding acquisition N.G.; investigation, A.M.-G. and M.C.G.-A; methodology S.V. and J.L.L-L.; project administration N.G.; resources N.G.; software S.V.; supervision S.V and N.G.; validation J.L.L.-L.; visualization P.M.; roles/writing – original draft, A.M.-G.; writing – review & editing S.V. and N.G.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.amp.2023.12.012.

References

[1] Bennett RM, Friend R, Jones KD, Ward R, Han BK, Ross RL. The Revised Fibromyalgia Impact Questionnaire (FIQR): validation and psychometric properties. Arthritis Res Ther 2009;11:R120.
[2] Bertsch J. Le créativitè motrice. Son evaluation et son optimisation dans la pédagogie des situations motrices a l'ecole – Manuel de tests [Motor Creativity. Evaluation and Optimization in the Pedagogy of Physical Education – Test Manual]. Paris: INSEP; 1983 [Google Scholar].
[3] Beveridge SK. The relationship among motor creativity, movement satisfaction, and the utilization of certain movement factors of second grade children. Dissertation Abstr Int 1974;34:7022-A.
[4] Brennan MA. Relationship between creative ability in dance and selected creative attributes. Percept Motor Skill 1982;55:47–56.
[5] Bujang MA, Baharum N. A simplified guide to determination of sample size requirements for estimating the value of intraclass correlation coefficient: a review. Arch Orofac Sci 2017;12(1):1–11.
[6] Burckhardt CS, Clark S, Bennett R. Fibromyalgia and quality of life: a comparative analysis. J Rheumatol 1993;20:475–9.
[7] Buysse DJ, Reynolds 3rd CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193–213.
[8] Carlson LE, Bultz BD. Mind–body interventions in oncology. Curr Treat Opt Oncolog 2008;9:127–34.
[9] Carson N, Leach L, Murphy KJ. A re-examination of Montreal Cognitive Assessment (MoCA) cutoff scores. Int J Geriatr Psychiatry 2018;33:379–88.
[10] Chan A-W, Tetzlaff JM, Altman DG, Laupacis A, Gøtzsche PC, Krleža-Jerić K, et al. SPIRIT 2013 statement: defining standard protocol items for clinical trials. Ann Intern Med 2013;158:200–7.
[11] Cheron G, Petit G, Cheron J, Leroy A, Cebolla A, Cevallos C, et al. Brain oscillations in sport: toward EEG biomarkers of performance. Front Psychol 2016;7:246.
[12] Collado-Mateo D, Adsuar JC, Olivares PR, Cano-Plasencia R, Gusi N. Using a dry electrode EEG device during balance tasks in healthy young-adult males: test-retest reliability analysis. Somatosens Mot Res 2015;32:219–26.
[13] Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35:1381–95.
[14] Delgado C, Araneda A, Behrens MI. Validation of the Spanish-language version of the Montreal Cognitive Assessment test in adults older than 60 years. Neurología (English Edition) 2019;34:376–85.
[15] DODDS P. Creativity in movement: models for analysis. 1978;12:265–4.
[16] Fink A, Graif B, Neubauer AC. Brain correlates underlying creative thinking: EEG alpha activity in professional vs. novice dancers. NeuroImage 2009;46:854–62.
[17] Galvez-Sánchez CM, Montoro CI, Duschek S, del Paso GAR. Depression and trait-anxiety mediate the influence of clinical pain on health-related quality of life in fibromyalgia. J Affect Disord 2020;265:486–95.
[18] Gaudreault N, Boulay P. Cardiorespiratory fitness among adults with fibromyalgia. Breathe 2018;14:e25–33.
[19] Gilchrist H, Haynes A, Oliveira JS, Grunseit A, Sherrington C, Bauman A, et al. The value of mind-body connection in physical activity for older people. J Aging Phys Activ 2022;25:81–8.
[20] Glover E. Motor creativity test for college women. (Doctoral dissertation, University of North Carolina – Greensboro). Dissertation Abstr Int 1974;35:1909 [University Microfilms No. 74–22, 343].
[21] Harbourne RT, Stergiou N. Movement variability and the use of nonlinear tools: principles to guide physical therapist practice. Phys Ther 2009;89:267–82.
[22] Herdman M, Gudex C, Lloyd A, Janssen M, Kind P, Parkin D, et al. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). Qual Life Res 2011;20:1727–36.
[23] Hita-Contreras F, Martínez-López E, Latorre-Román PA, Garrido F, Santos MA, Martínez-Amat A. Reliability and validity of the Spanish version of the Pittsburgh Sleep Quality Index (PSQI) in patients with fibromyalgia. Rheumatol Int 2014;34:929–36.
[24] Hobson J. The Montreal Cognitive Assessment (MoCA). Occup Med (Oxford England) 2015;65:764–5.
[25] Hristovski R, Davids K, Araujo D, Passos P. Constraints-induced emergence of functional novelty in complex neurobiological systems: a basis for creativity in sport. Nonlinear Dyn Psychol Life Sci 2011;15:175.
[26] Huijnen IP, Verbunt JA, Meeus M, Smeets RJ. Energy expenditure during functional daily life performances in patients with fibromyalgia. Pain Pract 2015;15:748–56.
[27] Iguina MM, Kashan S. Art therapy. StatPearls Publishing; 2021.
[28] Jung TP, Makeig S, Westerfield M, Townsend J, Courchesne E, Sejnowski TJ. Removal of eye activity artifacts from visual event-related potentials in normal and clinical subjects. Clin Neurophysiol 2000;111:1745–58.
[29] Kalfon TB-O, Gal G, Shorer R, Ablin JN. Cognitive functioning in fibromyalgia: the central role of effort. J Psychosom Res 2016;87:30–6.
[30] Kenning G, Visser M. Evaluating quality of life and well-being at the intersection of dementia care and creative engagement. Dementia (London England) 2021;20:2441–61.
[31] Khalil R, Moustafa AA. A neurocomputational model of creative processes. Neurosci Biobehav Rev 2022;137:104656.
[32] Kuchinad A, Schweinhardt P, Seminowicz DA, Wood PB, Chizh BA, Bushnell MC. Accelerated brain gray matter loss in fibromyalgia patients: premature aging of the brain? J Neurosci 2007;27:4004–7.
[33] Laban R, Ullmann L. The mastery of movement. Macdonald & Evans; 1971.
[34] Leon-Llamas JL, Villafaina S, Murillo-Garcia A. Impact of fibromyalgia in the hippocampal subfields volumes of women—An MRI study. Int J Environ Res Public Health 2021;18:1549.

[35] Lomas-Vega R, Hita-Contreras F, Mendoza N, Martínez-Amat A. Cross-cultural adaptation and validation of the Falls Efficacy Scale International in Spanish postmenopausal women. Menopause (New York NY) 2012;19:904–8.
[36] Lomas-Vega R, Rodríguez-Almagro D, Peinado-Rubia AB, Zagalaz-Anula N, Molina F, Obrero-Gaitán E, et al. Joint assessment of equilibrium and neuromotor function: a validation study in patients with fibromyalgia. Diagnostics (Basel Switzerland) 2020;10(12):1057–74.
[37] Lopata JA, Nowicki EA, Joanisse MF. Creativity as a distinct trainable mental state: an EEG study of musical improvisation. Neuropsychologia 2017;99:246–58.
[38] Marques AP, Santo AdSdE, Berssaneti AA, Matsutani LA, Yuan SLK. Prevalence of fibromyalgia: literature review update. Rev Bras Reumatol 2017;57:356–63.
[39] Mas A, Carmona L, Valverde M, Ribas B. Prevalence and impact of fibromyalgia on function and quality of life in individuals from the general population: results from a nationwide study in Spain. Clin Exp Rheumatol 2008;26:519.
[40] Méndez–Martínez E, Fernández–Río J. Diseño y validación de un instrumento de medición de la creatividad motriz en adolescentes. Rev Int Med Cien Actividad Física Deporte 2019;19:535–50.
[41] Mullen TR, Kothe CA, Chi YM, Ojeda A, Kerth T, Makeig S, et al. Real-time neuroimaging and cognitive monitoring using wearable dry EEG. IEEE Trans Biomed Eng 2015;62:2553–67.
[42] Murillo-Garcia A, Leon-Llamas JL, Villafaina S, Rohlfs-Dominguez P, Gusi N. MoCA vs. MMSE of fibromyalgia patients: the possible role of dual-task tests in detecting cognitive impairment. J Clin Med 2021;10(1):125–35.
[43] Murillo-Garcia A, Leon-Llamas JL, Villafaina S, Gusi N. Fibromyalgia impact in the prefrontal cortex subfields: an assessment with MRI. Clin Neurol Neurosurg 2022;219:107344.
[44] Murillo-Garcia A, Adsuar JC, Villafaina S, Collado-Mateo D, Gusi N. Creative versus repetitive dance therapies to reduce the impact of fibromyalgia and pain: a systematic review and meta-analysis. Complement Ther Clin Pract 2022;47:101577.
[45] Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005;53:695–9.
[46] Orth D, Van der Kamp J, Memmert D, Savelsbergh GJP. Creative motor actions as emerging from movement variability. Front Psychol 2017;8:1903.
[47] Queiroz LP. Worldwide epidemiology of fibromyalgia. Curr Pain Headache Rep 2013;17:356.
[48] Rasyada AR, Zulaika H, Akutagawa M, Emoto T, Kinouchi Y, Azhim A. The impact of visceral fat and blood flow velocity in hypertensive subjects running head: the impact of visceral fat and blood flow velocity. Health Sci J 2016;10:1.
[49] Rehfeld K, Lüders A, Hökelmann A, Lessmann V, Kaufmann J, Brigadski T, et al. Dance training is superior to repetitive physical exercise in inducing brain plasticity in the elderly. PLoS One 2018;13:e0196636.
[50] Roman-Viñas B, Serra-Majem L, Hagströmer M, Ribas-Barba L, Sjöström M, Segura-Cardona R. International physical activity questionnaire: reliability and validity in a Spanish population. Eur J Sport Sci 2010;10:297–304.
[51] Ruffini G, Dunne S, Farres E, Cester I, Watts PCP, Silva SRP, et al., editors. ENOBIO dry electrophysiology electrode; first human trial plus wireless electrode system. Conf Proc IEEE Eng Med Biol Soc. 2007.
[52] Salgueiro M, García-Leiva JM, Ballesteros J, Hidalgo J, Molina R, Calandre EP. Validation of a Spanish version of the Revised Fibromyalgia Impact Questionnaire (FIQR). Health Qual Life Outcomes 2013;11:132.
[53] Sampedro A, Pena J, Ibarretxe-Bilbao N, Sánchez P, Iriarte-Yoller N, Pavón C, et al. Neurocognitive, social cognitive, and clinical predictors of creativity in schizophrenia. J Psychiatr Res 2020;129:206–13.
[54] Santos S, Monteiro D. Uncovering the role of motor performance and creative thinking on sports creativity in primary school-aged children. Creativity Res J 2021;33:1–15.
[55] Sherrill C. Fostering creativity in handicapped children. Paper Inter Symp Fedr. Adapt Phys Activ Q 1985;3:236–49.
[56] Stergiou N. Innovative analyses of human movement: analytical tools for human movement research. Human Kinetics; 2004.
[57] Tocci N, Scibinetti P, Mazzoli E, Mavilidi MF, Masci I, Schmidt M, et al. Giving ideas some legs or legs some ideas? Children's motor creativity is enhanced by physical activity enrichment: direct and mediated paths. Front Psychol 2022;13:806065.
[58] Torrance EP. Predictive validity of the Torrance tests of creative thinking. J Creative Behav 1972;6:236–62.
[59] Verbunt JA, Pernot DH, Smeets RJ. Disability and quality of life in patients with fibromyalgia. Health Qual Life Outcomes 2008;6:8.
[60] Walker MP. The role of sleep in cognition and emotion. Ann N Y Acad Sci 2009;1156:168–97.
[61] Weir JP. Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. J Strength Cond Res 2005;19:231–40.
[62] Winstein CJ. Knowledge of results and motor learning—implications for physical therapy. Phys Ther 1991;71:140–9.
[63] Wolfe F, Clauw DJ, Fitzcharles MA, Goldenberg DL, Katz RS, Mease P, et al. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. Arthritis Care Res (Hoboken) 2010;62:600–10.
[64] Wolfe F, Clauw DJ, Fitzcharles MA, Goldenberg DL, Katz RS, Mease P, et al. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. Arthritis Care Res 2010;62:600–10.
[65] Wyrick W. The development of a test of motor creativity. Res Q Am Assoc Health Phys Educ Recreation 1968;39:756–65.
[66] Yardley L, Beyer N, Hauer K, Kempen G, Piot-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). Age Ageing 2005;34:614–9.