BRIEF REPORT
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Brain Impairment

Spanish translation and cross-cultural adaptation of the Box and Block Test: a pilot study in adults with chronic acquired brain injury

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ABSTRACT

Background. The Box and Block Test (BBT) is a highly recommended outcome measure to assess unilateral gross motor activity of the upper limbs. The BBT has not previously been available in a version adapted to the Spanish context. Thus, this study aimed to cross-culturally adapt and translate the BBT's instructions and pilot test the Spanish version of BBT in adults with acquired brain injury (ABI). **Methods.** The BBT was translated and cross-culturally adapted following standard procedures. An expert committee approved the final Spanish version of BBT and it was conceptually validated by four therapists with expertise in ABI. The tool was tested on 14 adults with ABI. **Results.** The Spanish version of BBT included a new section of materials for the test and a record to count the number of blocks transferred from one compartment of the box to the other. Following the pilot study, a modification in terminology was implemented for referring to the dominant and non-dominant hands. **Conclusions.** Our results suggest that the Spanish version of BBT is suitable for assessing manual dexterity in Spanish-speaking adults with ABI.

Keywords: acquired brain injury, Box and Block Test, cross-cultural adaptation, manual dexterity, motor deficits, pilot test, rehabilitation, upper limb outcome measure.

Introduction

Acquired brain injury (ABI) can impact different areas of the brain, leading to a range of symptoms, including motor deficits, memory loss, impulsivity, and mental health issues. ABI can be categorised into two subtypes: traumatic brain injury (TBI) and non-traumatic brain injury (non-TBI). TBI results from external factors such as motor vehicle accidents and falls, while non-TBI is caused by internal brain-damaging processes such as stroke and tumours (Goldman *et al.* 2022). Stroke is a significant global contributor to disability, particularly disabilities affecting motor function and manual dexterity (Hatem *et al.* 2016; Plantin *et al.* 2022). Losing manual dexterity can have a negative impact on activities such as reaching for and collecting objects, affecting patients' quality of life (Hatem *et al.* 2016; Birchenall *et al.* 2019). Thus, assessing manual dexterity using reliable and valid tools is essential to plan effective rehabilitation and monitor recovery. This assessment is especially critical in ABI, where motor deficits, including manual dexterity, are pivotal for a patient's rehabilitation.

The Box and Block Test (BBT) was originally developed to evaluate manual dexterity in people with upper limb impairments (Mathiowetz *et al.* 1985). This test is widely used in clinical practice and research to assess and monitor the progress of manual dexterity and motor activity in individuals with conditions affecting hand function, such as stroke, cerebral palsy, or other neurological disorders (Alt Murphy *et al.* 2015; Connell and Tyson 2012; Demers and Levin 2017). In the Spanish adult population, the BBT has been used as an outcome measure of upper limb activity in chronic stroke (Sentandreu-Mañó *et al.* 2021; Aguilera-Rubio *et al.* 2022; García-Bravo *et al.* 2024), Parkinson's disease (Bissolotti *et al.* 2024), spinal cord injury (García-Alén *et al.* 2023), cerebral palsy

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(Cornejo *et al.* 2022), and multiple sclerosis (Martínez-Piédrola *et al.* 2021; Cuesta-Gómez *et al.* 2022; Sánchez-Herrera-Baeza *et al.* 2022; Jovellar-Isiegas *et al.* 2023). This test is strongly recommended by European (Prange-Lasonder *et al.* 2021) and Spanish (Madroñero-Miguel and Cuesta-García 2023) experts in upper limb neurorehabilitation as a valid and feasible outcome measure of activity level according to the International Classification of Function (ICF).

To our knowledge, no prior study has assessed the validity and psychometric properties of the BBT in Spanish-speaking ABI survivors. Therefore, as a first step towards establishing the feasibility and applicability of the BBT as an assessment tool in this population, this study aimed to translate and cross-culturally adapt the BBT's instructions, pilot test these instructions, and administer the BBT test with Spanish patients with an ABI.

Patients and methods

Study design

This study is part of the InstrumenTO-DCA project, an ancillary study within the broader InstrumenTO initiative conducted by the Research Group in Occupational Therapy (InTeO) at Universidad Miguel Hernández (https://inteo.edu.umh.es/). The InstrumenTO-DCA project focuses on the translation, cross-cultural adaptation, and validation of cognitive and manual dexterity assessment tools for Spanish-speaking individuals with ABI.

This cross-sectional pilot study was designed to translate and adapt the BBT instructions into Spanish. The aim was to evaluate the applicability and interpretability of these instructions from both the examiner's perspective during administration and the patients' perspective during performance. Specifically, we assessed the ease of administration for the evaluators, ensuring the instructions were clear and straightforward to follow, and the ease of completion for the patients, ensuring that the instructions were understandable and executable without difficulty.

Participants

The study was targeted to adults with ABI, including TBI and non-TBI individuals. Participants were recruited from two clinical centres: Unidad de Daño Cerebral, Hermanas Hospitalarias Valencia (Valencia) and Unidad Funcional de la Mano (Alicante). Participants were selected based on the expert evaluation of therapists, who assessed their range of motion. This evaluation included the assessment of participants' active articular motion, ensuring that they exhibited minimal neuromuscular activation, which allows for flexion-extension of the elbow. Specifically, participants were required to show a minimum elbow flexion of 30°, along with shoulder and wrist positioning that maintained a neutral stance. This assessment was deemed sufficient for determining eligibility, and no specific motion task was required prior to inclusion.

Participants were included if they met the following criteria:

- Aged 45–70 years.
- Diagnosed with ABI and in the subacute or chronic stage ($\geq$3 months post-ABI).
- Receiving care in outpatient, residential, or home settings.
- Adequate comprehension and use of the Spanish language.

Exclusion criteria included:

- Cognitive impairment (Mini-Mental State Examination score $<$24).
- Visual and auditory deficits that would impede the ability to perform the test.
- Issues with comprehension.
- Presence of an upper limb amputation.
- Pharmacological treatments that could impact cognitive function.

The final sample comprised 13 patients with stroke and one patient with a brain tumour. Socio-demographic (sex, age, education level, presence of a caregiver) and clinical (type of diagnosis, date of diagnosis, hand dominance, upper limb impairment, and current medications) data were also collected to provide a comprehensive understanding of the participants.

Box and Block Test

The BBT is an assessment tool widely used in rehabilitation and occupational therapy to evaluate manual dexterity. It specifically assesses unilateral gross motor skills, focusing on the use of hands and arms. The test measures an individual's ability to grasp, manipulate, and release objects, providing valuable insights into their manual dexterity and fine motor skills (Mathiowetz *et al.* 1985; Oña *et al.* 2020). The test involves 150 cubes of different colours and a box with two compartments. The aim is to transfer as many cubes as possible from one compartment to the other within 1 min, using both hands. In this study, we employed the BBT as described by Mathiowetz *et al.* (1985). The box features a base with a width of 53.7 cm, a height of 8.5 cm, and a length of 25.4 cm. The partition inside the box measures 25.4 cm by 15.2 cm, and each individual cube has dimensions of 2.5 cm cubed. Detailed information on the BBT materials and complete instructions are included in Supplementary material S1.

Administration procedure

In our study, the BBT was administered following standardised procedures to ensure consistency and accuracy. The test setup involved the following steps:

1. Preparation:
   - The test environment was arranged to provide participants with sufficient space and comfort.
   - Participants were seated in a standard stationary chair facing the testing table.
   - Whenever possible, the test was performed first with the least-affected hand and then with the most-affected hand.
   - The evaluator ensured that participants had the necessary time for correct positioning of their hands. If assistance was needed for positioning, the evaluator provided support.
   - Whenever necessary, the evaluator fixed the box to the table using non-slip tablecloths.
2. Instructions:
   - The evaluator provided each participant with clear verbal instructions on how to perform the test, ensuring that participants understood the task.
3. Practice session:
   - A 15-s practice session was provided to ensure that the task was fully understood by the participant before the actual test commenced.
4. Execution:
   - The test was conducted in a quiet environment to minimise distractions.
   - A timer was used to enforce the 1-min time limit strictly.
   - Participants were instructed to transfer as many cubes as possible from one compartment of the box to the other within 1 min, starting with their least-affected hand.
5. Scoring:
   - The number of cubes successfully transferred from one compartment to the other within the allotted time was recorded.
   - Scores were used to assess manual dexterity and were analysed for each hand separately.

Process of translation and cross-cultural adaptation of the Box and Block Test instructions into Spanish

The Spanish version of the BBT instructions was obtained through standardised procedures for translating and adapting tests (Muñiz *et al.* 2013), supported by an expert committee, as follows:

- Step 1 (direct translation): Two independent translators produced translations from English into Spanish (T1 and T2).
- Step 2 (first expert committee review): An expert committee, comprising four occupational therapists with experience in neurology and two methodologists, synthesised T1 and T2 into a single version. The committee compared the two translations to check their semantic and cultural appropriateness and ensure the original meaning was maintained. Discrepancies were discussed and resolved by introducing semantic and idiomatic changes and conceptual/technical adaptations as necessary. The first version of the BBT instructions (BBT-E 1) was then approved.
- Step 3 (concept review): The content of BBT-E 1 was analysed by four occupational therapists, all with expertise in working with ABI patients and administering the BBT. This resulted in a second version of the BBT (BBT-E 2).
- Step 4 (back translation): BBT-E 2 was translated back into English (T3) by a translator unfamiliar with the original instructions, to check for consistency with the original version.
- Step 5 (pilot testing): BBT-E 2 was pilot tested with a sample of participants. Participants were interviewed about the translated BBT version and were asked questions such as 'Are the instructions clear?' and 'Do you have any questions regarding the test's instructions?' Additionally, evaluators made observations during the administration of the test, noting the clarity and interpretability of the instructions and any issues related to scoring. The feedback and observations were analysed to refine the instructions further.
- Step 6 (final version): Based on the feedback from the pilot testing, the BBT instructions were revised (BBT-E 3), and this version represented the final translated and cross-culturally adapted BBT for use with Spanish-speaking ABI individuals.

Pilot testing of the Spanish version of the Box and Block Test instructions

A pilot testing phase was conducted with 14 ABI survivors to evaluate the translated BBT instructions (BBT-E 2). During this phase, the BBT was administered by a single evaluator, who guided participants through the testing process in a controlled environment. Throughout the test, the evaluator observed participants to identify any issues related to comprehension or scoring. After completing the test, participants provided feedback through structured interviews regarding the clarity and usability of the instructions. This comprehensive approach aimed to pinpoint areas for improvement before finalising the instructions.

Ethics approval

This study was approved by the ethics committee of the General University Hospital of Alicante (Acta 2023-08). All participants provided their signed consent form.

Statistical analysis

All analyses were performed using R statistical software (ver. 4.2.2, http://www.r-project.org). We performed descriptive analyses to provide an overview of participants'

characteristics and BBT scores. Frequencies and percentages were used for the categorical variables, while mean and standard deviation were used for normally distributed quantitative variables. For quantitative variables not normally distributed, median and interquartile range (IQR) were used. The normality of the quantitative variables was assessed using the Kolmogorov–Smirnov test with the Lilliefors correction.

Results

Table 1 displays the most relevant discrepancies that occurred during the translation and cross-cultural adaptation process. One issue involved blocks falling onto the table or floor during the test. In such cases, we were uncertain about whether the block should be counted. To address this, we contacted the original author of the BBT, who clarified that a block should be counted if the fingers have correctly passed the partition, regardless of whether it falls inside or outside the box (e.g. onto the table or floor). Moreover, in the original BBT version, the evaluation process distinguished between dominant and non-dominant hands, starting the assessment with the dominant hand. However, the expert committee recognised the potential for confusion among evaluators since the test did not specify whether dominance referred to pre-ABI or post-ABI condition. As a solution, based on the clinical data obtained from each patient during the pilot testing, the terms 'dominant hand' and 'non-dominant hand' were replaced with 'least-affected hand' and 'most-affected hand'. This determination of 'most-affected hand' and 'least-affected hand' was based on the patient's lateral affection as a consequence of an ABI, and the collected information was accordingly updated. This modification aimed to eliminate potential confusion arising from determining hand dominance after a neurological disorder. Additionally, two instructions were incorporated to guide participants on hand positioning and the option to secure the box to the table. These instructions include that participants will have the necessary time for the correct positioning of their hands; similarly, if help is needed for positioning, the evaluator will assist them. Moreover, whenever necessary, the evaluator may secure the box to the table using non-slip tablecloths. Another challenge was the lack of clarity in the instructions, which resulted in confusion between the evaluator and the assessed person regarding who the instructions were intended for. Lastly, the expert committee, composed of occupational therapists experienced in administering the BBT, refined the block-counting method by counting the number of block transfers from one side to the other of the box. To further simplify block counting during the test, the committee considered adding a square to the record sheet to designate a specific area for tallying block transfers. This was to help evaluators to count the blocks while the test was being administered and

Table 1. Analysis and resolutions during the process of translation and cross-cultural adaptation of the BBT instructions made by the expert committee.

BBT	Problem(s)	Solution(s)
General information	There was confusion about how to count the blocks that fell onto the table or floor.	The blocks that fell to the ground or to the table were counted, without penalising the assessed person as long as the fingers had crossed the partition.
	There was a need to change the terms 'dominant hand' and 'non-dominant hand' to 'least-affected hand' and 'most-affected hand' to avoid confusion regarding the patient's hand dominance after an ABI.	The terms 'dominant' and 'non-dominant' were replaced with 'least-affected' and 'most-affected' in all BBT instructions.
Materials	The absence of a description about the materials used during the test.	A materials section was added to describe them, with an image with the measurements of the box.
Patient instructions	It was difficult to differentiate between instructions addressed to the evaluator and those directed to the assessed person.	A paragraph was added to differentiate the meaning of italicised text from non-italicised text. Italicised text was directed to the assessed person and non-italicised text to the evaluator, offering guidance or instructions on how to conduct the assessment. In addition, it was decided to rename this item 'Instructions' to improve clarity.
Scoring	There was confusion about how to count the blocks in the test, because if the assessed person passed more than one block at once, it had to be noted, and the number of blocks was subtracted from the total. This could take more time and be confusing.	It was proposed to tally the score during the test, counting the number of times that the assessed person transported blocks correctly.
	There was confusion regarding how to count the blocks that fell onto the table or floor.	Blocks that fell to the ground or onto the table were included in the count without penalising the assessed individual as long as the fingers had crossed the partition.
BBT record sheet	There was a need to add a square to the record sheet to count the blocks during the test.	A square was inserted into the record sheet, for use by the evaluator, to record the number of times the assessed person transported blocks.

enhance clarity in the counting process. Participant feedback indicated that there were no issues with the comprehension of BBT instructions. The responses reviewed by the expert committee suggested that the language used was appropriate for the intended audience.

Table 2 shows the sociodemographic characteristics of the participants. There was an equal number of men and women, with seven participants in each group. The participants had an average age of 57.2 years (s.d. = 12.5), with 42.9% of them being older than 60. Out of the total participants, 64.3% had primary education or less, 85.7% did not have caregiver support, and 92.9% were right-handed. Additionally, more than half had an impairment in the right upper limb (57.1%), and all participants had minor or moderate impairment severity reported by their therapists. This assessment permitted them to complete the BBT evaluation, as each participant had a sufficient range of motion to perform the tasks required. The participants had a median time of 8.8 months (IQR: 6.9–17.9) from the onset of ABI before the test session.

The results of the pilot testing of the Spanish version of the BBT instructions are presented in Table 3. The participants achieved a median of 19.5 blocks in 1 min with their most-affected hand, while they scored a median of 39.0 blocks with their least-affected hand.

Table 2. Sociodemographic and clinical characteristics of the participants in the pilot testing (n = 14).

Characteristic	*n* (%)
Sex	
Woman	7 (50.0)
Man	7 (50.0)
Age, mean (s.d.)	57.2 (12.5)
≤60 years	8 (57.1)
>60 years	6 (42.9)
Education level	
≤Primary education	9 (64.3)
>Primary education	5 (35.7)
Patient with a caregiver	
Yes	2 (14.3)
No	12 (85.7)
Dominance	
Left	1 (7.1)
Right	13 (92.9)
Most affected upper limb	
Left	6 (42.9)
Right	8 (57.1)
Months from stroke onset to the test session, median (IQR)	8.8 (6.9–17.6)

Discussion

This study aimed to address a significant gap in the literature by focusing on the cross-cultural adaptation and translation of the BBT instructions into Spanish for ABI survivors By following a comprehensive procedure that included direct translation, expert committee review, concept review, back translation, pilot testing, and finalisation, we ensured the accuracy and validity of the Spanish version of the BBT instructions. This adaptation is crucial as it provides healthcare professionals with a reliable tool to assess manual dexterity in Spanish-speaking populations, where such resources have been notably lacking.

Selecting appropriate assessment tools for clinical practice can be challenging (Gor-García-Fogeda *et al.* 2014). Currently, there is a lack of formally translated and cross-culturally adapted upper limb assessment tools specifically designed for use after an ABI (Madroñero-Miguel and Cuesta-García 2023), with existing tools in Spanish primarily focusing on cognitive assessment (Walsh *et al.* 2022; Salazar-Frías *et al.* 2023). However, the BBT stands out as a simple tool for evaluating manual dexterity in patients with upper limb impairments, making it valuable for healthcare professionals. Therefore, translating and adapting the BBT into Spanish can be helpful for the assessment of ABI survivors.

During the translation and cross-cultural adaptation process, the expert committee successfully addressed discrepancies that arose during direct translation (translation A and B). These discrepancies included situations where the assessed person collected more than one block at a time, as well as instances where the blocks fell onto the table or the floor. This careful attention to detail ensured that the instructions were clear and suitable for the target population.

Through the pilot testing conducted with individuals affected by ABI, this study provided valuable insights into participants' manual dexterity capabilities by evaluating both the most-affected and least-affected upper limbs. The results shed light on the differences between the two upper limbs, enabling evaluators to gather crucial information for designing effective rehabilitation sessions targeted at patient recovery and functional outcomes. Despite being

Table 3. Comparison of BBT scores between most-affected and least-affected upper limb in the pilot testing (n = 14).

Upper limb	Total number of transferred blocks
Most-affected hand, median (IQR)	19.5 (11.8–38.0)
Least-affected hand, median (IQR)	39.0 (34.0–42.8)

based on a small sample, participant feedback indicated that there were no reported issues with the comprehension of BBT instructions across different educational backgrounds. This observation suggests that educational level does not significantly impact the understanding of the instructions. Participants, regardless of whether they had primary or higher education, reflected an adequate level of understanding of the instructions provided. Consequently, the BBT proves to be a suitable assessment tool for individuals with different educational backgrounds, ranging from primary education to higher education, ensuring its applicability across a wide range of ABI cases.

The adapted and translated BBT instructions, along with the pilot testing of the BBT, have several potential implications. First, the availability of the BBT instructions in Spanish improves accessibility and inclusivity for Spanish-speaking ABI survivors, reducing language barriers and ensuring accurate understanding of the instructions. Second, the standardised approach used in the translation and adaptation process allows for consistent administration of the test across different Spanish-speaking populations, facilitating reliable comparisons and progress tracking. Third, the pilot testing provides valuable insights into the manual dexterity capabilities of ABI survivors, guiding the development of targeted interventions and therapy plans. Additionally, the cultural and linguistic considerations involved in the translation and adaptation process promote cultural sensitivity and enhance the accuracy of assessments. Fourth, the pilot testing serves as a foundation for future research and validation, allowing health professionals to contribute to the ongoing validation process and improve the reliability and applicability of the Spanish BBT. Overall, the Spanish BBT should enhance the assessment and rehabilitation of Spanish-speaking ABI survivors, ultimately leading to improved patient outcomes and quality of care.

However, several limitations should be acknowledged. First, the small sample size limits the generalisability of our findings. Our study primarily focused on ABI survivors, but the sample was predominantly composed of individuals with stroke in the chronic phase of recovery. This may represent a population-representative issue, as the lack of diversity in ABI types limits our ability to draw conclusions applicable to a broader range of ABI survivors.

Second, as a pilot study, the primary aim was to assess feasibility rather than definitive efficacy, which inherently restricts broader conclusions. While participant feedback indicated adequate comprehension of the instructions, it is important to note that this feedback is subjective and may not fully capture the complexities of understanding among individuals with cognitive impairments.

Third, we acknowledge that the study's findings may be influenced by cultural and contextual factors that were not fully explored, which could affect the applicability of the translated and adapted version of the BBT instructions across different populations.

Conclusion

This study has provided a translated and cross-culturally adapted Spanish version of the BBT instructions for professionals working with ABI patients. This assessment tool promises enhanced evaluation of unilateral gross motor skills among Spanish-speaking patients, leading to optimised rehabilitation strategies and patient outcomes. As a future line of research, it is essential to explore the psychometric properties of this tool to ensure its effectiveness across diverse ABI populations.

Supplementary material

Supplementary material is available online.

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Ethics standard. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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