

A Brazilian-Portuguese version of the Kinesthetic and Visual Motor Imagery Questionnaire

Versão brasileira do Questionário de Imagética Motora Cinestésica e Visual

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ABSTRACT

Motor imagery has emerged as a potential rehabilitation tool in stroke. The goals of this study were: 1) to develop a translated and culturally-adapted Brazilian-Portuguese version of the Kinesthetic and Visual Motor Imagery Questionnaire (KVIQ20-P); 2) to evaluate the psychometric characteristics of the scale in a group of patients with stroke and in an age-matched control group; 3) to compare the KVIQ20 performance between the two groups. **Methods:** Test-retest, inter-rater reliabilities, and internal consistencies were evaluated in 40 patients with stroke and 31 healthy participants. **Results:** In the stroke group, ICC confidence intervals showed excellent test-retest and inter-rater reliabilities. Cronbach's alpha also indicated excellent internal consistency. Results for controls were comparable to those obtained in persons with stroke. **Conclusions:** The excellent psychometric properties of the KVIQ20-P should be considered during the design of studies of motor imagery interventions for stroke rehabilitation.

Keywords: rehabilitation; paresis; stroke; reproducibility of results.

RESUMO

A Imagética Mental é uma ferramenta em potencial para a reabilitação de indivíduos com doenças cerebrovasculares. Os objetivos desse estudo foram: 1) Desenvolver uma versão traduzida e adaptada culturalmente do Questionário de Imagética Motora Cinestésica e Visual (KVIQ20-P); 2) Avaliar as características psicométricas da escala nesse grupo e em controles; 3) Comparar o desempenho na escala entre os dois grupos. **Métodos:** Confiabilidades teste-reteste, interexaminador, assim como consistências internas da KVIQ20-P foram avaliadas em 40 indivíduos com AVC e em 31 controles. **Resultados:** No grupo de pacientes, os intervalos de confiança mostraram excelentes confiabilidades teste-reteste e interexaminador. O alfa de Cronbach indicou uma excelente consistência interna. Os resultados no grupo controle foram comparáveis aos obtidos nos pacientes. **Conclusões:** As excelentes propriedades psicométricas da KVIQ20-P devem ser consideradas durante o desenho de estudos de Imagética Mental para a reabilitação de indivíduos com doenças cerebrovasculares.

Palavras-chave: reabilitação; paresia; acidente vascular cerebral; reprodutibilidade dos testes.

Motor imagery consists of mentally evoking a motor act without actually doing it. The neural representation of motor acts, as well as their visual and kinesthetic properties, are therefore activated through the mental process of imagination^{1,2}. Perception, action, and imagery share common neural pathways involving mainly the frontal and parietal areas of the brain^{3,4,5,6,7}. Considering the latest developments in the field, there is no consensus on the level of imagery proficiency required to perform motor imagery interventions effectively.

There are large differences in performance among individuals, and various instruments have been developed to measure motor imagery ability. Among these instruments, the Kinesthetic and Visual Motor Imagery Questionnaire (KVIQ) is widely used^{1,8,9}. The KVIQ consists of 20 items (KVIQ₂₀) clustered into two 10-item subscales (visual, KVIQ_{10V} and kinesthetic, KVIQ_{10K}). The KVIQ₂₀ scores range from 20 to 100, while the KVIQ_{10V} and KVIQ_{10K} scores each range from 10 to 50, with greater scores indicating greater aptitude in motor imagery.

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This scale was specifically created for people with physical disabilities¹ and has been reliable when applied to individuals with stroke, in different parts of the world^{1,8}.

Motor imagery is potentially a very attractive rehabilitation concept for countries facing substantial challenges in the provision of stroke rehabilitation. One of the critical aspects in this endeavor is the availability of adequate measures of the extent of motor imagery in persons with stroke. The strong evidence base using the KVIQ scale in English-speaking countries makes it an excellent candidate for this purpose. Therefore, the present study comprised: 1) the development of a translated and culturally adapted Brazilian-Portuguese version of the KVIQ (KVIQ-P); 2) evaluation of the psychometric characteristics of the scale in the stroke group and in an age-matched control group; 3) comparison of the KVIQ-P performance in persons with stroke and in controls.

METHOD

Subjects

For the stroke group, participants were recruited through databases of the Stroke Group at Hospital das Clínicas/São Paulo University and a primary care clinic in the São Paulo metropolitan area between December, 2010 and April, 2014. The candidates were contacted and invited to complete a telephone screening. Eligible participants were then invited for testing in the neurostimulation laboratory at Hospital das Clínicas. Age- and gender-matched controls were recruited among acquaintances of the participants or researchers.

Inclusion criteria for the stroke group were: a minimum age of 21 years, single unilateral ischemic stroke in one cerebral hemisphere leading to hemiparesis, more than six months before and confirmed by computed tomography or magnetic resonance imaging; ability to understand the protocol and provide written informed consent. The exclusion criteria were: Mini-Mental State Examination (MMSE) scores lower than the cut-offs for literate (24/30) or illiterate adults (20/30; it is estimated that 8.3% of Brazilians older than 15 years are illiterate)^{10,11}; use of drugs affecting cognition or balance such as benzodiazepines, neuroleptics and antiepileptic drugs¹²; history of other neurological conditions; uncontrolled medical disease; blindness¹³ and severe congenital or acquired visual deficits; history of depression and alcohol abuse, evaluated with DSM-V criteria¹⁴, and other psychiatric conditions such as psychosis or schizophrenia reported by participants and/or their caregivers. Because the study provided groundwork for a project on motor imagery in lower limb recovery, we also excluded participants with a Berg Balance Scale > 54 points, as lower scores are associated with an increased risk of falls (maximum score, 56 points)¹⁵ and the goal of the rehabilitation project was to improve balance and decrease this risk. Figure 1 shows the flow of persons with stroke throughout the study.

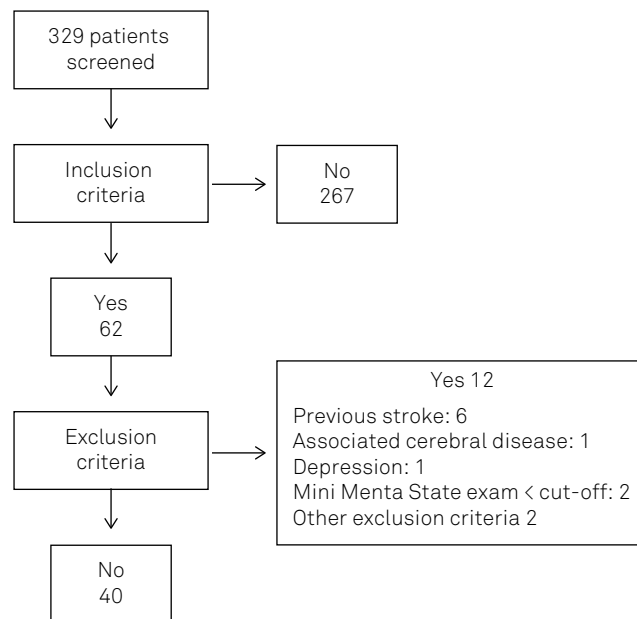


Figure. Flow of participants through the study.

To test the psychometric properties of the KVIQ-P in controls, as well as to compare performances between persons with stroke and controls, a healthy control group with comparable demographic characteristics ($n = 31$) was also recruited. Inclusion criteria were: minimum age of 21 years; ability to understand the protocol and provide written informed consent. Exclusion criteria were: history of stroke and the same criteria applied to the stroke group.

The protocol was approved by the Ethics Committee of the Hospital das Clínicas/São Paulo University (protocol number 0471/09) and all participants provided written informed consent.

Translation and cultural adaptation

We followed the guiding principles for cultural adaptation of assessment instruments¹⁶⁻¹⁹. Two independent Brazilian specialists in the English language translated the original KVIQ₂₀ version into Brazilian Portuguese. Two independent Brazilian-Portuguese health professionals with English proficiency (a psychologist and a physical therapist) did the back-translation. The versions were compared to check the linguistic equivalence and consistency and a single version was defined by consensus between native speakers of Portuguese.

In the next step, this version of the KVIQ₂₀ was piloted in five participants with stroke. Based on the feedback obtained from these participants in a post-testing interview regarding clarity and understandability of the instrument, the questions were refined and finalized to the Brazilian-Portuguese version of the KVIQ administered for the study (KVIQ-P; supplementary file).

Movements imagined in the KVIQ include actions of all body segments. There are specific tests for imagined

movements of the upper limbs, tests for imagined movements of the lower limbs, as well as the neck and trunk. All movements are executed, and then imagined while the subject is seated.

Determination of psychometric properties of the KVIQ-P₂₀, KVIQ-P_{10V} and KVIQ-P_{10K}

Three parameters, internal consistency, intra-rater and inter-rater reliability were determined for the stroke and the control groups respectively. For intra-rater reliability, the participants were retested within one to two weeks of the first test. All evaluations were videotaped and rated by Researcher 1. For inter-rater reliability, Researcher 2 rated the videotaped performance of the first test, and the scores of the two raters were compared. Internal consistencies of the KVIQ-P₂₀, KVIQ-P_{10V} and KVIQ-P_{10K} were calculated.

Comparison between the KVIQ performance in persons with stroke and controls

The KVIQ-P₂₀, KVIQ-P_{10V} and KVIQ-P_{10K} scores of the first evaluations of the stroke group and control group were compared. Considering that people with stroke often had deficits such as dysarthria, hemiparesis or aphasia, among others, blinding of the evaluations was not possible.

Statistics

Data were described by means \pm standard deviations for normally-distributed variables, and by medians and ranges if otherwise. Frequencies were calculated for categorical variables. The Kolmogorov-Smirnov test revealed that the data were not normally distributed and hence nonparametric tests were used for within-subject comparisons (performances in the KVIQ-P₂₀, KVIQ-P_{10V} and KVIQ-P_{10K}: Wilcoxon test) and between-group comparisons (KVIQ-P₂₀, KVIQ-P_{10V} and KVIQ-P_{10K}: Mann-Whitney tests).

Internal consistencies of the KVIQ-P₂₀ scale, as well as their subscales were evaluated with Cronbach's alpha test²⁰. The score of each item was compared with the total score by Cronbach's alpha correlation if an item was deleted. Consistencies were classified according to Bland and Altman²⁰. A Cronbach's alpha between 0.70 and 0.80 is considered satisfactory for a reliable comparison between groups and a minimum of 0.90 is required for a scale used for clinical purposes, while values of at least 0.95 are considered desirable.

Intra-rater reliability (first application of the scale vs. second application) and inter-rater reliability (Researcher 1 direct evaluation of the first application vs. evaluation of the videotapes of the first application by Researcher 2) were analyzed with the Intraclass Correlation Coefficient test (ICC) applied in a two-way random model with total agreement and classified as²¹: ICC < 0.40 = poor reliability; ICC \geq 0.40 but \leq 0.75 = fair to good reliability; and ICC > 0.75 = excellent reliability. The ICCs for the KVIQ-P₂₀ and its subscales (KVIQ-P_{10V} and KVIQ-P_{10K}) were determined.

Inter-item correlations were calculated if an item was deleted to search for items that could cause inconsistencies because of extreme values. Values of 0.40–0.50 inter-item correlation are required for scales tapping narrower characteristics, as is the case of the KVIQ-P₂₀, based on fewer items²².

All data were tested with the SPSS18 statistical software.

RESULTS

Characteristics of the participants

Table 1 gives an overview of participant characteristics for both groups. There were no significant differences between demographic characteristics of persons with stroke and the controls ($p > 0.05$). A large proportion was under the age of 65: $n = 33$ (82.5%) in the stroke group, and $n = 24$ (77.4%) in the control group. Twenty-eight (70%) of the participants in the stroke group, and 21 (67.7%) of the controls had eight years of education or more. The mean time from stroke (\pm standard deviation) was 3.6 ± 2.2 years. In 62.5% of the persons with stroke, lesions were located in the right hemisphere. The mean Berg Balance Scale score was 44.7 ± 9 in the stroke group.

Psychometric properties

The internal consistency of the KVIQ-P₂₀ and the consistency of each subscale are presented in Table 2. Intra-rater and inter-rater reliabilities of the KVIQ-P₂₀, as well as the KVIQ-P_{10V}/KVIQ-P_{10K} subscales, were excellent according to the criteria adopted in both groups. Table 3 shows inter-item correlations.

Comparison between the KVIQ-P performance in persons with stroke and controls

The KVIQ-P performance was comparable between the stroke and control groups for the KVIQ-P₂₀ (66.0 ± 16.3 /stroke group; 66.1 ± 21.3 /control group), KVIQ-P_{10V} (32.7 ± 9.6 /stroke group; 33.0 ± 11.8 /control group) and KVIQ-P_{10K} (33.1 ± 8.5 /stroke group; 33.1 ± 10.6 /control group). None of these numerical differences between groups were statistically significant (KVIQ-P₂₀ $p = 0.68$; KVIQ-P_{10V} $p = 0.80$; KVIQ-P_{10K} - $p = 0.61$).

Table 1. Characteristics of the participants. Means and standard deviations or medians and ranges are given.

Characteristics	Stroke group	Control group
Age (years)	54.8 \pm 12.6	55.2 \pm 12.9
Education (years)	9.3 \pm 4.9	9.4 \pm 4.6
Mini-mental state examination	27 (20–30)	29 (25–30)
KVIQ-P ₂₀	66.0 \pm 16.3	66.1 \pm 21.3
KVIQ-P _{10V}	32.7 \pm 9.6	33.0 \pm 11.8
KVIQ-P _{10K}	33.1 \pm 8.5	33.1 \pm 10.6

KVIQ-P₂₀: kinesthetic and visual motor imagery questionnaire – full scale; KVIQ-P_{10V}: kinesthetic and visual motor imagery questionnaire – visual subscale; KVIQ-P_{10K}: kinesthetic and visual

Table 2. Reliability of the Brazilian version of the Kinesthetic and Visual Motor Imagery Questionnaire (KVIQ-P₂₀) and its subscales.

Reliability	Stroke Group			Control Group		
	KVIQ-P ₂₀	KVIQ-P _{10V}	KVIQ-P _{10K}	KVIQ-P ₂₀	KVIQ-P _{10V}	KVIQ-P _{10K}
Intra-rater	ICC = 0.85 (0.74–0.92)	ICC = 0.87 (0.77–0.93)	ICC = 0.75 (0.57–0.86)	ICC = 0.90 (0.81–0.95)	ICC = 0.90 (0.81–0.95)	ICC = 0.82 (0.67–0.91)
	p < 0.001	p < 0.001	p < 0.001	p < 0.001	p < 0.001	p < 0.001
Inter-rater	ICC = 0.99 (0.99–1.00)	ICC = 0.99 (0.99–1.00)	ICC = 0.99 (0.99–0.99)	ICC = 0.99 (0.99–0.99)	ICC = 0.99 (0.99–0.99)	ICC = 0.99 (0.99–0.99)
	p < 0.001	p < 0.001	p < 0.001	p < 0.001	p < 0.001	p < 0.001
Internal consistency	$\alpha = 0.94$	$\alpha = 0.95$	$\alpha = 0.94$	$\alpha = 0.97$	$\alpha = 0.97$	$\alpha = 0.95$

KVIQ-P₂₀: kinesthetic and visual motor imagery questionnaire – full scale; KVIQ-P_{10V}: kinesthetic and visual motor imagery questionnaire – visual subscale; KVIQ-P_{10K}: kinesthetic and visual motor imagery questionnaire – kinesthetic subscale; ICC: intraclass coefficient correlation.

Table 3. Internal consistency. Cronbach's alpha for correlation between the KVIQ-P₂₀ score, KVIQ-P_{10V} and KVIQ-P_{10K} scores if item deleted.

Item	Stroke group			Control group			
	KVIQ ₂₀ Cronbach's alpha if item deleted	Item	Cronbach's alpha if item deleted	KVIQ ₂₀ Cronbach's alpha if item deleted	Item	Cronbach's alpha if item deleted	
	KVIQ ₂₀		KVIQ _{10V}	KVIQ ₂₀		KVIQ _{10V}	
V01	0.941	V01	0.930	V01	0.974	V01	0.970
V02	0.938	V02	0.929	V02	0.975	V02	0.971
V03	0.936	V03	0.919	V03	0.974	V03	0.969
V04	0.936	V04	0.916	V04	0.973	V04	0.969
V05	0.936	V05	0.916	V05	0.973	V05	0.968
V06	0.936	V06	0.917	V06	0.975	V06	0.972
V07	0.938	V07	0.923	V07	0.975	V07	0.969
V08	0.937	V08	0.925	V08	0.974	V08	0.968
V09	0.936	V09	0.923	V09	0.975	V09	0.969
V10	0.934	V10	0.916	V10	0.974	V10	0.969
Item	KVIQ ₂₀		KVIQ _{10K}	KVIQ ₂₀		KVIQ _{10K}	
K01	0.939	K01	0.904	K01	0.976	K01	0.953
K02	0.938	K02	0.893	K02	0.976	K02	0.956
K03	0.936	K03	0.885	K03	0.974	K03	0.952
K04	0.937	K04	0.886	K04	0.974	K04	0.950
K05	0.938	K05	0.891	K05	0.974	K05	0.954
K06	0.936	K06	0.892	K06	0.976	K06	0.957
K07	0.938	K07	0.893	K07	0.974	K07	0.949
K08	0.940	K08	0.904	K08	0.974	K08	0.950
K09	0.939	K09	0.898	K09	0.974	K09	0.949
K10	0.937	K10	0.894	K10	0.973	K10	0.946

KVIQ-P₂₀: kinesthetic and visual motor imagery questionnaire – full scale; KVIQ-P_{10V}: kinesthetic and visual motor imagery questionnaire – visual subscale; KVIQ-P_{10K}: kinesthetic and visual motor imagery questionnaire – kinesthetic subscale.

DISCUSSION

The current research aimed to adapt and evaluate the psychometric properties of a Brazilian-Portuguese version of the most commonly-used motor imagery questionnaire in English-speaking countries, the KVIQ-P. Overall, the

results of this study suggest that the Brazilian-Portuguese version of the KVIQ has strong psychometric characteristics. Specifically, we obtained excellent intra- and inter-rater reliabilities for the full scale (KVIQ-P₂₀), as well as the subscales (KVIQ-P_{10V} and KVIQ-P_{10K}), in persons with stroke, as well as healthy control participants. Moreover,

internal consistencies were good and matched the criteria for useful scales for research and clinical purposes in both groups. There were no statistically significant differences in the KVIQ-P performance between the groups.

Our results were similar to those reported for the original English version of the KVIQ-P₂₀, KVIQ-P_{10V} and KVIQ-P_{10K} in Canadians with stroke¹, both in terms of performance and psychometrics. Similar methodologies were used in the original Canadian study and in our protocol. Our study tested more subjects (n=40) than the Canadian study (n = 19), although the latter included more controls (46 in theirs vs. 31 in ours). We found similar results in the control group when compared with the original study. The present study, therefore, not only expands the evidence base for the psychometric properties of the KVIQ to the Brazilian-Portuguese context, but further enhances the specific evidence base for KVIQ data in persons with stroke. As such, it adds an important component to the literature reporting reliability and consistency of the KVIQ₂₀ or its subscales in participants with multiple sclerosis²³, Parkinson's disease⁹ and a mixed sample of participants with stroke, brain tumors, multiple sclerosis or Parkinson's disease²⁴. These previous studies in populations with different neurological conditions reported intra-rater reliability, not inter-rater reliability. The present research contributes to this body of research and, most critically, does so for a sizable and well-controlled stroke population. Overall, these results suggest that the KVIQ₂₀, KVIQ_{10V} and KVIQ_{10K} are reliable and consistent across cultures, in people with diverse neurological conditions, as well as in healthy participants.

Mirroring the findings for intra-rater and inter-rater reliabilities, the internal consistencies of the Brazilian-Portuguese version of the KVIQ₂₀ and of its subscales were very good (Cronbach- α ranged from 0.94 to 0.97 across the main scale, subscales and groups) and fulfilled the quality criterion for reliable comparisons between clinical groups as specified by Bland and Altman²⁰. Again, this suggests that our version of the KVIQ-P has excellent psychometric characteristics overall.

Most of our participants in the stroke group were younger than 65 years, had more than eight years of education and normal MMSE scores. In other words, most participants were relatively young, educated, and did not have overt cognitive impairments, which means that, despite the stroke, they were a homogeneous and favorable group for motor imagery tasks. These results indicate that, in contrast to many other cerebral capacities, motor imagery may not suffer expressive damage

in participants with a profile similar to those included in this study, or may recover due to plastic mechanisms in such individuals. Therefore, motor imagery interventions may be useful in stroke rehabilitation when other motor and sensory-based rehabilitation systems are compromised, at least in a subset of subjects.

The current research has limitations. While the sample size is not as large and diverse as one might consider ideal, the number of participants tested here was larger than in all other reports of the KVIQ₂₀ performances in participants with stroke. Secondly, the first rater tested participants in person, while the second rater rated performances videotaped by the first rater. This approach has been used in other studies^{25,26}. Thirdly, specific lesion data was not available and therefore we were unable to comment on the influence of the lesion site on the KVIQ performance. A better understanding of the impact of different lesion sites on motor imagery performance is clearly an important question that should be addressed in the future.

Former work²⁷ described and translated the KVIQ₂₀ into Portuguese, but this version had not previously been validated. Likewise, other tools to quantify motor imagery like the Motor Imagery Questionnaire and the Vividness Motor Imagery Questionnaire were not yet validated in Portuguese-speaking individuals.

CONCLUSIONS

The present study shows excellent psychometric characteristics for the Brazilian-Portuguese version of the KVIQ and, as such, strengthens the portfolio of tools available to study motor imagery in the Brazilian population. Moreover, the study expands a small body of research, conducted in various countries, suggesting that motor imagery in persons with stroke might be comparable to control populations²⁸. This has implications for rehabilitation protocols. Specifically, it is well accepted that imagery reinforces the neural activity involved in the execution of motor programs, and can therefore enhance motor performance and learning^{29,30}. Reliable tools to assess motor imagery are key to trials aiming at evidence-based imagery protocols to improve clinically meaningful outcomes in people with stroke. The excellent psychometric properties of the KVIQ-P₂₀, KVIQ-P_{10V} and KVIQ-P_{10K} should be taken into consideration during the design of such trials.

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