Journal of Neurology & Experimental Neuroscience

https://doi.org/10.17756/jnen.2022-098

Research Article

Open Access

Principal Components Analysis of the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) in Patients with Multiple Sclerosis

Samuel T. Gontkovsky[1, 2*], David S. Kreiner[3] and Joseph J. Ryan[3]

[1]*Adena Health System, Chillicothe, Ohio, USA*

[2]*The Ohio State University, Wexner Medical Center, College of Medicine, Department of Psychiatry and Behavioral Health, Columbus, Ohio, USA*

[3]*University of Central Missouri, Warrensburg, Missouri, USA*

***Correspondence to:**
Samuel Thomas Gontkovsky
Adena Health System, Chillicothe, Ohio, USA
Tel: 601-214-2182
E-mail: sgontkovsky@hotmail.com

Received: October 17, 2022
Accepted: December 21, 2022
Published: December 23, 2022

Citation: Gontkovsky ST, Kreiner DK, Ryan JJ. 2022. Principal Components Analysis of the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) in Patients with Multiple Sclerosis. *J Neurol Exp Neurosci* 8(2): 35-38.

Published by United Scientific Group

Abstract

Background and Objective: Research examining the construct validity of the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) using heterogeneous clinical samples generally has not supported the scale's theoretically-derived factor structure. A recent study, however, has offered validation for the scale's index structure in patients diagnosed with probable Alzheimer's disease, highlighting the importance of evaluating the construct validity of neuropsychological tests in homogeneous patient samples. This investigation therefore sought to validate the index structure of the RBANS in a homogeneous sample of patients with multiple sclerosis.

Method: Participants were 89 patients diagnosed with multiple sclerosis by board certified neurologists who were referred for outpatient neuropsychological testing. The RBANS was part of a fixed-flexible battery of measures administered according to standardized testing procedures.

Results: Results of a principal components analysis provided a two-factor model for the RBANS, consisting of components primarily but not exclusively involving memory and visual-spatial perception.

Conclusion: Findings of this study are consistent with the majority results in this line of RBANS research and suggest that sample heterogeneity may not be the underlying basis for repeated failures to support the scale's theoretically derived index structure.

Keywords

Assessment, Multiple sclerosis, Neuropsychology, Principal components analysis, RBANS

Introduction

Numerous factor-analytic investigations have sought to validate empirically the theoretically derived index structure of the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) [1, 2]. Most have not offered support for the test's five-factor structure and instead have suggested a two-factor solution, commonly consisting of models primarily but not exclusively involving memory and visual-spatial perception [3-8]. A recent study using confirmatory factor analysis in participants with probable Alzheimer's disease, however, reported that the proposed five-factor structure of the RBANS, as described in the test's manual, fit the data relatively well [9]. The authors proposed that the failure of prior research to find support for the index structure of the RBANS may well reflect the fact that in most instances the samples under investigation were

diagnostically heterogeneous and therefore suggested that the examination of a test's construct validity should be conducted with specific homogeneous rather than heterogeneous clinical samples.

This investigation was conducted to build upon this line of research, analyzing the index structure of the RBANS using principal components analysis in a diagnostically homogeneous and representative sample of patients with multiple sclerosis (MS). Based on the results of the Holden, Milano, and Horner [9] investigation, it was hypothesized that the theoretically derived index structure of the RBANS would be validated in this homogeneous sample of MS patients. It also was hypothesized that the primary component extracted from the data would be comprised primarily by the scale's memory subtests.

Materials and Methods

Participants

Participants (n = 89) consisted of individuals diagnosed with MS [10] by board-certified neurologists and were being followed for medical management of their disease at hospital systems located in the southeastern, midwestern, and western United States. Patients were referred for neuropsychological evaluation as a component of a comprehensive medical workup. Patients did not have any documented visual deficits or distal upper extremity motor limitations and demonstrated during testing both sufficient visual acuities to read without accommodations other than prescription lenses and sufficient upper extremity motor functioning to write without obstacle. Additionally, no patients had documented auditory deficiencies that may have limited execution of the assessment battery. More than half of the participants were diagnosed with relapsing-remitting MS (55%); the remainder had been diagnosed with a progressive form of MS (37% secondary progressive and 8% primary progressive). Patients had not experienced an exacerbation of illness during at least the prior six months prior to the time of the neuropsychological evaluation, and all of them were taking disease-related medications as prescribed (68% immunomodulation, 54% antidepressant, 51% analgesic, 49% muscle relaxant, and 38% anti-fatigue). Participants (58 females, 31 males) ranged in age from 25 to 70 years (M = 48.99, SD = 9.29) and had a mean level of education of 14.28 years (SD = 2.05). Racial composition of the sample was 91% White, 7% Black, 1% Latino/Hispanic, and 1% American Indian.

Measure

Repeatable Battery for the Assessment of Neuropsychological Status [1, 2]

The RBANS is an individually administered measure that provides a concise examination of the primary domains of cognitive functioning. The scale is comprised of 12 subtests, yielding five domain-specific index scores as well as a Total Scale index score. Each RBANS subtest contributes to only one of the scale's indices, with two subtests contributing to each specific index except for Delayed Memory, which is comprised of four subtests. The Immediate Memory index is comprised of the List Learning and Story Memory subtests. The Visuospatial/Constructional index is made up of the Figure Copy and Line Orientation subtests. The Language Index includes the Picture Naming and Semantic Fluency subtests. The Attention index is comprised of the Digit Span and Coding subtests. The Delayed Memory index includes the List Learning Recall, List Learning Recognition, Story Memory Recall, and Figure Recall subtests. Across subtests, items are summed to derive raw scores, which are converted to aged-based standard scores for the various domain-specific indices having a mean of 100 and standard deviation of 15. The domain-specific index scores are then summed and converted to a standard score to compute the Total Scale index. The research base of the RBANS is relatively extensive, and the measure generally has been shown to have sound psychometric properties and clinical utility in numerous diagnostic groups [2].

Procedure

The RBANS was administered and scored according to standardized procedures as part of a larger fixed-flexible battery of neuropsychological measures. IBM SPSS Statistics was utilized for all statistical analyses. This archival retrospective study and was conducted in accordance with the 1964 Helsinki Declaration [11] and its subsequent amendments as well as with the ethical principles of the American Psychological Association [12]. This investigation was approved by three separate institutional review boards.

Results

Descriptive statistics were computed to evaluate the mean scores of the sample on the RBANS. Individual scores of participants ranged from severely impaired to above average across all indices, with overall means ranging from 87.89 (SD = 17.06) on the Attention index to 95.65 (SD = 20.55) on the Visuospatial/Constructional index. The Total Scale index score for the sample fell within the below average range of functioning (M = 88.37, SD = 17.63, range = 46-126). Calculation of one-sample t-tests indicated that patients demonstrated significantly reduced performances on all of the RBANS index scores (with the exception of the Visuospatial/Constructional index, t = -2.00, p > .05) in comparison to the normative standardization sample mean of 100 and standard deviation of 15, with t values ranging from -4.50 to -6.70, p's < .0005.

Pearson correlations were computed to investigate the associations among both the RBANS indices and subtests. The 15 correlation coefficients among the index scores all were highly significant, p's < .0005. The weakest association was observed between the Immediate Memory index and the Visuospatial/Constructional index (r = .46), and the strongest relationship was seen between the Delayed Memory index and the Total Scale index (r = .87). Similarly, 60 of the 66 associations among the sample subtest scores were significant. The weakest relationship was seen between the subtests of Digit Span and List Learning Recall (r = .06, p = .60), and the strongest relationship was observed between the Story Memory subtest and the Story Memory Recall subtest (r = .80, p < .0005).

To investigate the RBANS index structure, a principal components analysis with varimax rotation and Kaiser nor-

malization was computed using the scale's 12 subtest scores. Analysis of the scree plot and the selection of components with eigenvalues >1 yielded a two-factor model, which accounted for 59.08% of the overall test variance (see Table 1). Rotated component loadings are provided in table 2. Nine and 10 of the 12 RBANS subtests loaded on components 1 and 2, respectively. Further, 7 of the 12 RBANS subtests loaded on both components. Component 1 included the six subtests of the RBANS specifically developed to assess memory, but both the Semantic Fluency subtest and Coding subtest had higher component loadings than the List Learning Recognition subtest and Figure Recall subtest. The Figure Copy subtest, Line Orientation subtest, and Figure Recall subtest had the highest loadings on component 2 and were at least 30% greater than the next highest subtest loading, which was the Picture Naming subtest. It also should be noted that component 2 included 4 of the 6 RBANS subtests that assess memory.

Table 1: Results of principal components analysis and varimax rotation.

Initial Eigen values					
Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
					Cumulative
Component	Total	% of Variance	Total	% of Variance	% of Variance
1	5.81	48.41	3.85	32.1	32.1
2	1.28	10.68	3.24	26.98	59.08
3	0.99	8.26			
4	0.83	6.95			
5	0.68	5.65			
6	0.57	4.73			
7	0.46	3.85			
8	0.44	3.63			
9	0.33	2.75			
10	0.26	2.2			
11	0.2	1.67			
12	0.15	1.22			

Table 2: Rotated component loadings of the RBANS subtests.

RBANS Subtests	1	2
List Learning	0.87	-
Story Memory	0.69	0.44
Figure Copy	-	0.77
Line Orientation	-	0.76
Picture Naming	0.32	0.55
Semantic Fluency	0.64	0.44
Digit Span	-	0.50
Coding	0.52	0.51
List Learning Recall	0.88	-
List Learning Recognition	0.45	0.36
Story Memory Recall	0.76	0.45
Figure Recall	0.42	0.71

Note: Component loadings below 0.30 were suppressed.

Discussion

This investigation sought to build upon the existing line of RBANS research examining the theoretically derived factor structure of the scale and, based on the recommendations of Holden et al. [9], to focus specifically on a diagnostically homogeneous sample of participants in doing so. Contrary to the findings of Holden and colleagues, the first hypothesis of this study was unsupported in that the five-factor index structure of the RBANS was not validated by our findings. Analyses instead yielded a two-factor model, which is consistent with the majority of published research in this area. The second hypothesis of this investigation was supported, as the primary component extracted from the data was comprised largely of the RBANS subtests emphasizing memory. Neither this component nor component 2, which most strongly represented visual-spatial construction/perception, was uncontaminated by subtests assessing more directly other cognitive processes, including information processing speed, language, and attention. The fact that nine of the scale's 12 subtests loaded on component 1 arguably validates the RBANS Total Scale index. These findings corroborate the recommendations of prior studies in this area that have cautioned against interpretation of the five RBANS index scores as distinct cognitive domains and have suggested greater reliance upon the scale's specific subtest scores in interpretation.

Nevertheless, research has shown the clinical utility of the RBANS in identifying the neurocognitive deficits associated with various forms of central nervous system injury/disease, including MS. Indeed, Davis, Williams, Gupta, Finch, and Randolph [13] reported that compared with demographically matched healthy controls, patients with MS perform more poorly on the RBANS domains of attention, language, immediate memory, and delayed memory. Further, Beatty [14] provided support for the RBANS verbal memory subtests in detecting and characterizing the memory impairments of MS, describing better recall of stories than recall of lists and better list recognition than list recall in patients with this disease.

Primary limitations of the present investigation include the relatively small size of the sample size as well as the lack of external neuropsychological variables to provide convergent/divergent validation of extracted components. Nevertheless, obtained results build on the existing literature in this area and suggest that diagnostic heterogeneity may not be the predominant underlying confound explaining numerous failures of prior research to support the five-factor index structure of the RBANS.

References

1. Randolph C, Tierney MC, Mohr E, Chase TN. 1998. Repeatable battery for the assessment of neuropsychological status manual. *J Clin Exp Neuropsychol* 20(3): 310-319. https://doi.org/10.1076/jcen.20.3.310.823
2. Randolph C. 2012. Repeatable battery for the assessment of neuropsychological status update manual. The Psychological Corporation, San Antonio, TX, USA.
3. Carlozzi NE, Horner MD, Yang C, Tilley BC. 2008. Factor analysis of the repeatable battery for the assessment of neuropsychological status. *Appl Neuropsychol* 15(4): 274-279. https://doi.org/10.1080/09084280802325124

4. Duff K, Langbehn DR, Schoenberg MR, Moser DJ, Baade LE, et al. 2006. Examining the repeatable battery for the assessment of neuropsychological status: factor analytic studies in an elderly sample. *Am J Geriatr Psychiatry* 14(11): 976-979. https://doi.org/10.1097/01.JGP.0000229690.70011.cd

5. Gontkovsky ST, Kreiner DS, Ryan J. 2020. Exploratory factor analysis of the repeatable battery for the assessment of neuropsychological status (RBANS) in adult patients with acquired brain injury and brain disease. *Archives of Assessment Psychology* 10(1): 19-26.

6. King LC, Bailie JM, Kinney DI, Nitch SR. 2012. Is the repeatable battery for the assessment of neuropsychological status factor structure appropriate for inpatient psychiatry? an exploratory and higher-order analysis. *Arch Clin Neuropsychol* 27(7): 756-765. https://doi.org/10.1093/arclin/acs062

7. Schitt AL, Livingston RB, Smernoff EN, Reese EM, Hafer DG, et al. 2010. Factor analysis of the repeatable battery for the assessment of neuropsychological status (RBANS) in a large sample of patients suspected of dementia. *Appl Neuropsychol* 17(1): 8-17. https://doi.org/10.1080/09084280903297719

8. Vogt EM, Prichett GD, Hoelzle JB. 2017. Invariant two-component structure of the repeatable battery for the assessment of neuropsychological status (RBANS). *Appl Neuropsychol Adult* 24(1): 50-64. https://doi.org/10.1080/23279095.2015.1088852

9. Holden HM, Milano NJ, Horner MD. 2020. Five-factor structure of the RBANS issupported in an Alzheimer's disease sample: implications for validation of neuropsychological assessment instruments. *Appl Neuropsychol Adult* 27(3): 232-242. https://doi.org/10.1080/23279095.2018.1529671

10. Polman CH, Reingold SC, Banwell B, Clanet M, Cohen JA, et al. 2011. Diagnostic criteria for multiple sclerosis: 2010 revisions to the McDonald criteria. *Ann Neurol* 69(2): 292-302. https://doi.org/10.1002/ana.22366

11. World Medical Association. 2013. World medical association declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA* 310(20): 2191-2194. https://doi.org/10.1001/jama.2013.281053

12. Ethical principles of psychologists and code of a conduct. [https://www.apa.org/ethics/code] Accessed on December 22, 2022

13. Davis A, Williams RN, Gupta AS, Finch WH, Randolph C. 2015. Evaluating neurocognitive deficits in patients with multiple sclerosis via a brief neuropsychological approach. *Appl Neuropsychol Adult* 22(5): 381-387. https://doi.org/10.1080/23279095.2014.949717

14. Beatty WW. 2004. RBANS analysis of verbal memory in multiple sclerosis. *Arch Clin Neuropsycho1* 19(6): 825-834. https://doi.org/10.1016/j.acn.2003.12.001