J Immigrant Minority Health (2011) 13:742–747
DOI 10.1007/s10903-011-9443-z

ORIGINAL PAPER

Assessing Neuropsychological Performance in a Migrant Farm Working Colonia in Baja California, Mexico: A Feasibility Study

Chad A. Bousman · Hugo Salgado · Terence Hendrix · Miguel Fraga · Mariana Cherner · VIIDAI Group

Published online: 25 January 2011

Abstract Neuropsychological impairments (NPI) can lead to difficulties in daily functioning and ultimately contribute to poor health outcomes. However, evidence for the feasibility of NPI assessment in resource-limited settings using tests developed in high literacy/high education cultures is sparse. The main objectives were to: (1) determine the feasibility and appropriateness of conducting neuropsychological assessments among a migrant farm worker population in Baja California, Mexico and (2) preliminary describe neuropsychological test performance in this unique population. A neuropsychological test battery was administered to 21 presumably healthy adults (8 men, 13 women) during a two-day international health services and research collaboration. All but one neuropsychological test (i.e. figure learning) was feasible and appropriate to administer to the study population. Contrary to expectations, participants performed better on verbal rather than nonverbal neuropsychological tests. Results support inclusion of neuropsychological tests into future studies among migrant farm worker populations in Baja California, Mexico.

Keywords Feasibility · Neuropsychological · Assessment · Mexico

The VIIDAI [Viaje (Travel), Interinstitucional (Inter-institutional), de Integracion (Integration), Docente (Teaching), Asistencia (Assistance) y de Investigacion (Investigation)] Group is a collaboration between the Faculty of Medicine and Psychology at Universidad Autónoma de Baja California (UABC), Graduate School of Public Health at San Diego State University (SDSU), School of Medicine at University of California, San Diego (UCSD) and Rotary International and includes: Co-Directors: Miguel A. Fraga, MD, Stephanie Brodine, MD; UABC Site Coordinators: Jaime Franco, MD, Roberto Escalante Guerrero, MD, MSc, Diana Garcia, MSc; SDSU Site Coordinators: John Elder, PhD, MPH, Alfonso Rodriquez, PhD; UCSD Site Coordinator: Richard Garfein, PhD.

C. A. Bousman (✉)
Department of Psychiatry, Royal Melbourne Hospital, University of Melbourne, Level 1 North, Parkville, VIC 3050, Australia
e-mail: cbousman@unimelb.edu.au

H. Salgado
San Diego Joint Doctoral Program in Public Health (Global Health), San Diego State/University of California, San Diego, CA, USA

T. Hendrix · M. Cherner
Department of Psychiatry, University of California San Diego, La Jolla, CA, USA

M. Fraga
Faculty of Medicine and Psychology, Universidad Autónoma de Baja California, Baja California, Mexico

Introduction

Neuropsychological impairments can lead to difficulties in daily functioning, poor adherence to both medical and behavioral interventions [1] and risky health behaviors (e.g. cigarette consumption) [2]. Thus, understanding the neuropsychological status of individuals and populations at risk for poor health outcomes could potentially be advantageous. Neuropsychological status information could be used to develop new and/or tailor existing interventions for individuals and/or populations for which intervention adherence is less than adequate [1]. However, in resource-limited settings where education and language fluency are presumably low, measures of neuropsychological status must be evaluated for feasibility, appropriateness, and utility [3–7]. To address the challenges of neuropsychological assessment in resource-limited settings we sought

to determine the feasibility and appropriateness of a brief neuropsychological test battery consisting of six (two verbal and four nonverbal) tests among residents of a migrant farm working colonia (i.e. neighborhood) in Baja California, Mexico.

Methods

Geographic Location and Cultural Background

The present study was conducted in the Lomas de San Ramón colonia in the San Quintín Valley of Baja California, Mexico; approximately 200 km south of the large municipality of Ensenada. The colonias of the San Quintín Valley are host to many immigrant communities from various indigenous groups from the Southern Mexican State of Oaxaca. Although the people of San Quintín Valley are primarily indigenous people, they do speak and understand Spanish and use it as their primary language. Children learn Spanish in school, and classes are taught in Spanish. Most people living in these colonias work in the agricultural fields as their primary occupation and it is not uncommon for an entire family, including the teenage children, to work as migrant farm workers.

Participants

Twenty-one presumed healthy volunteers (8 men and 13 women) aged 17–57 (mean = 32, SD = 10) years old were recruited during a 2-day period in 2010 as part of an on-going and long-standing international health services and research collaboration between the Faculty of Medicine and Psychology at Universidad Autónoma de Baja California, the Graduate School of Public Health at San Diego State University, and the School of Medicine at University of California, San Diego. The purpose of this international collaboration is to provide quality health services for the residents of the San Quintín Valley in Baja California, Mexico as well as opportunities to advance the understanding of the unique needs of this population. Residents of the colonia who were receiving health and medical services were referred to the study via medical staff informed of the study or were directly recruited by research assistants as residents waited to be seen by a medical professional. Education in the sample ranged from 0 to 10 (mean = 4, SD = 3), and participants reported employment as agricultural workers (67%; n = 14) or homemakers (33%; n = 7). All participants were able to speak and understand Spanish and were considered to be in good health, although formal review of medical records was not possible to conduct.

Assessment Battery

Selection of each assessment in the battery was based on brevity of administration, its availability in Spanish, as well as low literacy requirements (based on the assumption that the target population has low literacy level). Brevity was essential because only 30 min (typical wait time to see a doctor) was available to conduct the assessment. Two trained bachelor-level examiners administered the assessment battery in Spanish (in the order listed below) within a semi-private classroom adjacent to the clinic where participants were being seen. Participants were recruited and consented with the assistance of clinic team members as well as directly by the two examiners. On subject (S5) was 17 years of age and was assented prior to participation because a parent/guardian was unavailable in the colonia. During and following administration of the assessment battery, examiners noted participants difficulties and/or reactions to the tests. All procedures were approved by the Universidad Autónoma de Baja California, San Diego State University, and University of California, San Diego Institutional Review Boards. The complete battery consisted of seven assessments described below:

1. *Animal Fluency* [8, 9]: The Animal Fluency Test was selected as a measure of verbal category fluency. For this test, the participant was asked to name as many animals as possible within 1 min. The participant's score is the number of items correctly generated.
2. *Figure Memory Test* [10]: This test provides information on the participant's ability to learn and recall visual information. Participants were presented with three index cards that showed a total of four geometric designs. Each card was presented for 10 s, after which the participant was asked to draw from memory as many of the designs as possible on a blank sheet of paper. This procedure was repeated until the participant reached at least 15 points on a single trial, or until five learning trials had been completed. There was no time limit on this test and the highest trial divided by the number of trials completed was used as a measure of learning. The delayed recall portion was not administered.
3. *Hopkins Verbal Learning Test-Revised* (HVLT-R) [11]: A Spanish adaptation of the HVLT-R [12] was selected to provide information on each participant's ability to learn and recall verbal information. A list of 12 words was presented to the subject over three trials. After each trial, the subject was asked to recall as many items as possible from the list in any desired order. There was no time limit on this test and the total score across all three trials (range 0–36) was used.

4. *Grooved Pegboard Test* [13]: This test was used to measure manual motor speed and coordination. In this test, participants were required to place 25 small metal pegs into holes on a $3'' \times 3''$ metal board. All pegs were alike and had a ridge on one side, which corresponded to a notch in each hole on the board. Participants were instructed to place the pegs in the holes as fast as possible without skipping any holes. The dominant hand was tested first, followed by the non-dominant hand, and the total time to complete the task was recorded for each hand.
5. *Color Trails Tests 1 and 2* [14]: These two tests are a measure of processing speed and cognitive flexibility, respectively. Both tests use numbered colored circles and universal sign language symbols. The circles are printed with vivid pink or yellow backgrounds perceptible to colorblind individuals. For the Color Trails 1 trial, each participant used a pen to rapidly connect the circles numbered in a 1 through 25 sequence. For the Color Trails 2 trial, participants rapidly connected numbered circles in sequence, but were asked to alternate between pink and yellow colors. The length of time to complete each trial was recorded.
6. *Wechsler Memory Scale-III Spatial Span* [15]: Spatial Span was selected as a measure of visually attention and working memory. For this test, the examiner used a Spatial Span Board that features 10 cubes with numbers [1–10] printed on the sides of the cubes facing the examiner. The examiner tapped the cubes in a specified sequence and asked the participant to reproduce the sequence in the same order for the forward condition and in reverse order for the backward condition. Two trials for each sequence length were administered. There was no time limit for this test and the total number of correct forward and reverse sequences was used (range 0–32).
7. *Academic Skills Assessment*: A nine-question interview was used to collect information on each participant's frequency of reading, writing, and arithmetic in their everyday life. Questions used a four-point Likert format ranging from "never" to "often".

Statistical Analysis

Spearman correlations were conducted to explore associations between demographic variables (e.g. age, education) and raw neuropsychological performance. Gender differences were examined using the Wilcoxon (Mann–Whitney) test. On an exploratory basis, raw scores on each neuropsychological test were converted to demographically-adjusted (i.e. age, sex, education) T-scores (standard scores with a mean of 50 and standard deviation of 10) using previously established United States-Mexican border (Animal Fluency, List Learning, Grooved Pegboard) [12, 16] and rural Chinese (Color Trails, Spatial Span) [17] population norms. We chose to use rural Chinese norms for the color trails and spatial span tests because Spanish norms for these tests were not available and the Chinese participants from which the norms were derived, live and work in similar conditions and have comparable levels of education to those of the current study sample. For each test, T-scores less than 40 were coded as impaired. Global impairment was calculated by averaging all the T-scores using the same cut-off.

Results

Feasibility and Appropriateness of the Neuropsychological Tests

For all tests within the battery, participants were able to understand and successfully complete the test without difficulty, with the exception of the Figure Memory test. The first three participants struggled and administration of the test took considerably more time than anticipated (>25 min). Consequently, these difficulties and test administration time constraints prompted the removal of this test from the battery for subsequent participants. Examiners also noted that the Color Trails 2 posed challenges for several of the participants in our sample and significant prompting by the examiner during the test was often required.

Neuropsychological Performance and Impairment

Table 1 shows the raw scores on the administered tests for each participant, with the exception of the Figure Memory test. Performance on the neuropsychological tests, as measured by the average T-score did not differ by sex ($P > 0.05$) or significantly correlate with age or education ($P > 0.05$). Over half of participants reported reading (61%, n = 13), writing (71%, n = 15), and/or use of basic arithmetic (67%, n = 14) in their everyday life on a "sometimes-to-often" basis. Frequency of reading, writing, and math skills did not differ by sex and were not correlated with age, education, or performance on any of the neuropsychological tests, although a near significant positive correlation was observed between education and writing frequency (Spearman's rho = 0.41, $P = 0.06$). Figure 1 illustrates rates of impairment based on US-Mexico Border and rural Chinese norms for each of the neuropsychological tests administered. A majority (86%, n = 17) of participants exhibited global impairment with higher rates for the color trails 2 (81%) and the grooved

Table 1 Age, education, and raw scores on the neurocognitive tests for each participant

Variable/test	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	M (SD)
Age, years	57	32	39	18	17	32	32	32	30	20	37	35	26	32	28	44	23	22	35	50	31	32 (13)
Education, years	3	6	0	6	6	3	0	10	9	6	7	6	6	9	6	6	6	6	5	9	6	4 (3)
Sex	F	F	M	M	F	M	F	F	M	F	M	M	F	F	F	M	F	F	M	F	F	13F/8M
Animal fluency, total score	14	10	21	21	12	20	11	24	13	12	16	22	15	21	23	14	11	17	14	19	21	17 (5)
List learning, total score	12	23	26	25	24	26	18	23	9	23	17	28	21	30	29	20	17	23	19	28	27	22 (5)
Grooved pegboard dominant, seconds	106	90	70	90	67	59	70	94	72	110	67	58	100	112	84	99	103	63	143	147	106	81 (16)
Grooved pegboard non-dominant, seconds	86	82	93	90	76	52	92	80	80	112	66	104	101	119	73	95	113	75	132	183	118	81 (13)
Color trails 1, seconds	167	70	67	112	47	40	184	56	55	76	62	53	100	70	47	74	80	45	90	99	31	93 (56)
Color trails 2, seconds	600	171	128	196	103	90	251	148	196	156	162	200	140	156	127	184	207	95	260	204	97	211 (166)
Spatial span, total score	6	14	21	16	15	12	9	11	10	16	8	12	10	11	10	7	11	14	12	14	13	13 (5)

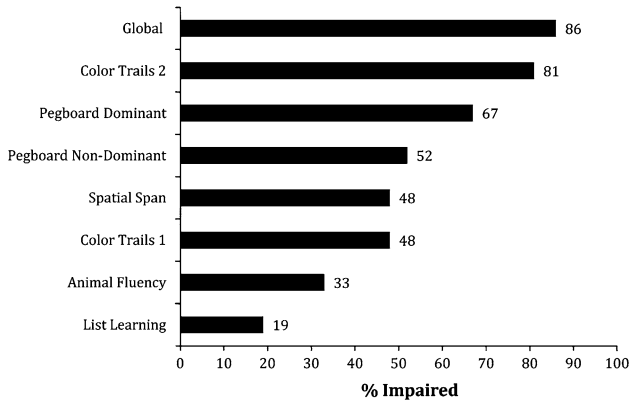

Fig. 1 Rates of neuropsychological impairment for each test based on demographically adjusted T-scores, using a cutpoint of T-score < 40. (N = 21)

pegboard (dominant hand: 67%; non-dominant hand: 52%) tests.

Discussion

At the onset of this study our primary aim was to determine whether the selected neuropsychological test battery was feasible and appropriate for use in a colonia consisting primarily of indigenous Mexican migrant farm workers. As previously mentioned, test selection was based on the assumption that participants would have limited education and literacy. By and large, this assumption was correct in that the average education of the participants was 4 years (SD = 3). However, more than 60% reported reading, writing, and using arithmetic in their daily lives.

Overall, the selected test battery was well received and none of the participants expressed frustration or appeared agitated with the testing procedures. However, the Figure Memory test was extremely difficult for the first three participants (S1, S2, S3) and was consuming significantly more time than anticipated and thus was removed from the battery for all subsequent testing. Discontinuing the administration of the Figure Memory test was further justified after examining performance on the other tests for these three participants. The first participant's (S1) performance on all the tests was relatively low, but the second (S2) and third (S3) participants did well on many of the other tests, suggesting that failure on the Figure Memory test was not reflective of generalized difficulties with the test battery; rather, an indication that this test may be inappropriate in this population. In fact, previous research [4] among Aruaco Indians in Columbia found that certain nonverbal measures were the least appropriate tests for cross-cultural use compared to verbal measures. In addition, Matute et al. [18] showed that literacy levels played a

subtle causal role on poor copying performance on a nonverbal stick construction task. This is supported in our semiliterate sample in that, on average, participants had relatively more difficulty on the nonverbal Color Trails 1 and 2 as well as the Grooved Pegboard and Spatial Span tests. Contrary to expectations, the majority of participants in this study performed well on both verbal tests (i.e. animal fluency and HVLT-R). However, this finding supports earlier research by da Silva et al. [19] that showed that verbal fluency (i.e. animals) and semantic memory (i.e. HVLT-R) test performance is dependent on the ecological relevance of the test content rather than literacy level.

This study should be interpreted in the context of several limitations. First and foremost, the sample used for this study was small (n = 21), with a limited range of age and education, and thus power to detect expected relationships between age, education, and NP test results was low. As such, findings are preliminary and not necessarily generalizable. Second, although participants were assumed to be in good health, we were unable to rule out the potential confounding effects of infectious disease (e.g. HIV, HCV, syphilis) or other chronic medical conditions (e.g. diabetes, heart disease), as well as the exposure to environmental toxins (e.g. pesticides), which may affect cognition. Third, we did not measure the degree of acculturation to United States' culture, from which the test battery was developed, among the participants. This factor may be confounding neuropsychological results in that a higher degree of acculturation could potentially result in better "test-wiseness" as a consequence of adopting United States' cultural elements. However, most participants performed below average on several of the nonverbal measures based on norms derived from a Mexican population living within the US-Mexico border region as well as a rural Chinese population, suggesting that those norms are not appropriate for interpreting test performance in this group of migrant farmer workers. Previous research has highlighted how culture can affect neuropsychological testing (see review: [20]) and that accurate cognitive assessment is dependent on both education and the cultural environment [21]. Thus, future studies should develop norms specific for a given cultural context and/or use study designs (e.g. control groups) that allow the assessment of cultural influences on cognitive functioning. Finally, we were only able to test a limited neuropsychological battery due to time constraints and participant burden. Although the selection of tests to be include in the battery was thorough, several alternative tests or longer batteries such as the NEUROPSI developed and standardized in Mexico [22] could have been selected for their feasibility and appropriateness in this population provided that sufficient time for administration is available.

Our results contribute to the growing body of research related to examination of neuropsychological assessment within resource-limited settings. We found that most of the examined neuropsychological tests were not only feasible but also appropriate for use in the study population. However, larger studies addressing the limitations mentioned above will be needed in order to accurately determine neuropsychological profiles and further fine-tune assessment protocols. Such information will undoubtedly assist in the development/tailoring of program materials for individuals and/or populations for which intervention adherence is low and subsequently will bolster the health, functioning, and safety of the migrant farm workers living in the San Quintin Valley and potentially other similar resource-limited settings.

Acknowledgments The authors wish to acknowledge support from University of California San Diego Academic Senate as well as Ernesto Ramirez, Christina Eisenberg, and David Macek for their assistance in data collection and Matthew Dawson for his technical assistance.

References

1. Fishbein DH, Hyde C, Eldreth D, Paschall MJ, Hubal R, Das A, et al. Neurocognitive skills moderate urban male adolescents' responses to preventive intervention materials. Drug Alcohol Depend. 2006;82(1):47–60.
2. Hall PA, Elias LJ, Crossley M. Neurocognitive influences on health behavior in a community sample. Health Psychol Official J Div Health Psychol Am Psychol Assoc. 2006;25(6):778–82.
3. Anger WK, Cassitto MG, Liang YX, Amador R, Hooisma J, Chrislip DW, et al. Comparison of performance from three continents on the WHO-recommended neurobehavioral core test battery. Environ Res. 1993;62(1):125–47.
4. Ardila A, Moreno S. Neuropsychological test performance in Aruaco Indians: an exploratory study. J Int Neuropsychol Soc. 2001;7(4):510–5.
5. Paul RH, Gunstad J, Cooper N, Williams LM, Clark CR, Cohen RA, et al. Cross-cultural assessment of neuropsychological performance and electrical brain function measures: additional validation of an international brain database. Int J Neurosci. 2007;117(4):549–68.
6. Pontius AA. Color and spatial error in block design in stone-age Auca Indians: ecological underuse of occipital-parietal system in men and of frontal lobes in women. Brain Cogn. 1989;10(1):54–75.
7. Rosselli M, Ardila A. The impact of culture and education on non-verbal neuropsychological measurements: a critical review. Brain Cogn. 2003;52(3):326–33.
8. Borkowski JG, Benton AL, Spreen O. Word fluency and brain damage. Neuropsychologia. 1967;5:135–40.
9. Gladsjo JA, Schuman CC, Evans JD, Peavy GM, Miller SW, Heaton RK. Norms for letter and category fluency: demographic corrections for age, education, and ethnicity. Assessment. 1999;6(2):147–78.

10. Heaton R, Grant I, Matthews C. Comprehensive norms for an expanded Halstead-Reitan Bat- tery: demographic corrections, research findings, and clinical applications. Odessa: Psychological Assessment Resources; 1991.
11. Brandt J, Benedict RH. Hopkins verbal learning test-revised: professional manual. Lutz: Psychological Assessment Resources, Inc; 2001.
12. Cherner M, Suarez P, Lazzaretto D, Fortuny LA, Mindt MR, Dawes S, et al. Demographically corrected norms for the Brief Visuospatial Memory Test-revised and Hopkins Verbal Learning Test-revised in monolingual Spanish speakers from the U.S.-Mexico border region. Arch Clin Neuropsychol. 2007;22(3): 343–53.
13. Klove H. Grooved Pegboard. Lafayette, IN: Lafayette Instruments; 1963.
14. D'Elia LF, Satz P, Uchiyama CL, White T. Color trails test: professional manual. Odessa: Psychological Assessment Resources, Inc; 1994.
15. Wechsler D. Wechsler adult intelligence scale. 3rd ed. San Antonio: The Psychological Corporation; 1997.
16. Artiola i Fortuny L, Hermosilla Romo D, Heaton RK, Pardee III RE. Manual de normas y procedimientos para la bateria neuropsicologica en Espanol. Tucson: m Press; 1999.
17. Heaton RK, Cysique LA, Jin H, Shi C, Yu X, Letendre S, et al. Neurobehavioral effects of human immunodeficiency virus infection among former plasma donors in rural China. J Neurovirol. 2008;14(6):536–49.
18. Matute E, Leal F, Zarabozo D, Robles A, Cedillo C. Does literacy have an effect on stick construction tasks? J Int Neuropsychol Soc. 2000;6(6):668–72.
19. da Silva CG, Petersson KM, Faisca L, Ingvar M, Reis A. The effects of literacy and education on the quantitative and qualitative aspects of semantic verbal fluency. J Clin Exp Neuropsychol. 2004;26(2):266–77.
20. Ardila A. Cultural values underlying psychometric cognitive testing. Neuropsychol Rev. 2005;15(4):185–95.
21. Ostrosky-Solis F, Ramirez M, Ardila A. Effects of culture and education on neuropsychological testing: a preliminary study with indigenous and nonindigenous population. Appl Neuropsychol. 2004;11(4):188–95.
22. Ostrosky-Solis F, Ardila A, Rosselli M. NEUROPSI: a brief neuropsychological test battery in Spanish with norms by age and educational level. J Int Neuropsychol Soc. 1999;5(5):413–33.